THE

ELECTRICAL REVIEW.

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EXPERT EVIDENCE IN THE LAW COURTS.

THE lecture by Prof. Victor Horsley, F.R.S., before the London Institution, which we publish in our other columns, gives us an opportunity of commenting on a matter which was finally settled only a few weeks ago.

In the course of the trial of Brasyer *v.* Harness and others, which occupied Mr. Justice Charles and a special jury for a whole week, it was deemed advisable to bring into the matter the evidence of electricians who had made experiments with electric belts, both connected and unconnected. One witness deposed to proving the existence of an electric current in the unconnected belts—that is, belts having no connection between zinc and copper to complete the circuit—and we shall proceed to show the worthlessness of his so-called proof. He had constructed a wooden mould made to the shape of a man's waist; around it he placed layers of felt, and then on the top he had a stretched skin of chamois leather sewn very tight. Outside of this skin he put a paste of iodide of potassium and starch, and on that paste he strapped the belt, an unconnected one. He left it for 12 hours, and at the end of that time he took the belt off, and then saw distinct traces of the current in brown marks due, as he asserted, to the passage of the current and the decomposition of iodide of potassium.

Now, the electrolysis or decomposition of iodide of potassium is well known, and may be performed with a single cell. The substance consists of iodine and potassium, and in its electrolysis the iodine is set free at the positive electrode and the potassium at the negative electrode. In performing the experiment with a single cell, a piece of bibulous paper (such as blotting paper) is soaked with a solution of starch and iodide of potassium. This paper is placed between the electrodes, and at the place where the positive pole touches it a *blue* spot is produced, due to the action of the liberated iodine upon the starch, the production of this blue colour with starch being an infallible test for free iodine.

Fortunately, or unfortunately, from the point of view one chooses to look at it, this witness admitted that he did not know anything about the chemical decomposition of the solution or paste he used, or that it was a chemical re-agent; so, doubtless, he will be surprised to learn that the stains he observed, and which, to him, proved the passage of an electric current, can be readily obtained by the action of light alone. A piece of bibulous paper, moistened with iodide of potassium and starch solution, and kept from the light for a couple of days, was still unstained; another piece exposed to the light showed brown marks freely. Saturated paper, on which was placed zinc discs with brass eyelets, and zinc discs with the eyelets extracted, showed precisely the same results as the witness exhibited in Court, and the china top of a tumbler electric light switch, placed on a piece of the

moistened paper, and exposed to the light, gave beautiful rings of brown colour, one outside, the other inside, where the light had penetrated through the hole in the top. A belt also gave the same indications, but in all these tests there was no passage of an electric current.

Two friends, chemists of repute, as well as electricians, undertook similar experiments, with precisely the same results.

This same witness, when asked by counsel if he had formed any idea as to the force (*sic*) of the physiological and natural electrical currents in the body, as compared with the force (*sic*) from the belt, said that he had tested the currents of electricity from his own body—from every point of his own body. He applied a plate of metal to his stomach, and another plate to the extremities; the toes, the fingers, the tongue, the forehead, and so forth. He took the electric force (*sic*) as discharged from a condenser, and also the actual current measured through a galvanometer.

The results obtained by this expert in electrical measurements were a revelation even to those who believe in the existence of natural body currents, for he asserted that the natural current between the region of his stomach and the forehead had a difference of potential of $\frac{7}{10}$ths of a volt, or, as he explained it, nearly that of a single Daniell cell.

Now, we have shown that the proof he brought forward as demonstrating the passage of an electric current in an unconnected belt, was wholly due to chemical decomposition; but, beyond all, and we wish to bring this point out very strongly, the witness, when under cross-examination, admitted that no current could be obtained under such conditions.

Q. Now, assuming that I have got here (illustrating) a cloth saturated with a saline solution, and I place a piece of copper *here*, and a piece of zinc *there*, do you say that a current of electricity would pass between these two—a current?

A. I should say not, distinctly. I should say it was an impossibility.

Counsel: So would everybody else.

Q. I am going to ask you one other question. Supposing you could have a surface of the human skin moistened with perspiration as much as you please, and you were to put a plate of zinc *there*, and a plate of copper *there*, unconnected, would a current pass between the two?

A. I should say not—certainly not. They must have some metal to pass.

Counsel: Of course, I quite agree.

Furthermore, the witness agreed that as the zinc discs had brass eyelets, the current, assuming there had been any, was possibly due to the action set up between zinc and brass. So much for the iodide of potassium and starch proof of the existence of electric currents, clearly rebutted both by the experiments we have quoted and by the witness's own admissions.

Apropos of body currents, we believe there are but few people who will not cordially agree with the evidence and lecture of Prof. Victor Horsley, F.R.S., who has devoted not a little of his time to researches on this very subject, and whose name is a sufficient guarantee for thoroughness in all that he undertakes. We know, also, that Prof. D. E. Hughes, F.R.S., has sought for these apparently mythical body currents by means of his induction balance, but he never observed the slightest trace. He has obtained effects when putting his finger or arm within the influence of the balance, but he invariably found the cause to be a metallic filing or dust adhering to the outer skin.

Still, the induction balance is not the most suitable apparatus to employ in these researches, therefore Prof. Hughes endeavoured to perceive the currents said to exist in the body by means of a sensitive magnetometer, for we know that a current cannot exist without a magnetic field. Even with this method he never obtained the faintest indication, and he is quite of Prof. Horsley's opinion that such currents do not really exist.

It seems incredible that a witness could stand in the box and talk glibly of the strong natural currents in his body, when the slightest consideration must have taught him that the very metals he used on his body produced the currents he observed. Why, for the purpose of observing whether natural body currents could ooze out of the toes or finger tips, did he not employ non-polarisable electrodes, electrodes which, in themselves, should be free from the ghost of a suspicion that they generated any current? Had he done so, he would neither have measured the force (*sic*) as discharged from a condenser, nor the actual current through a galvanometer, for there would have been nothing to discharge or to measure.

An experiment which we made at the time of the Tibbits *v.* Alabaster trial will illustrate this admirably, and at the same time act as an object lesson to the Mr. Paul, whose evidence was cut short by Mr. Justice Charles before he could finish how he, an assistant lecturer on literature, and with no pretence to special electrical knowledge, was induced to undertake the investigation of the Harness belt, to which a fee of 50 guineas was attached, and to write a report upon it.

We cut two pieces of copper from the same sheet, and connected them to the terminals of a very fine mirror galvanometer. By placing a hand upon each of these plates the needle was deflected very considerably, and the degree of movement of the needle could be varied, by more or less pressure with the right hand or left, by differences of oxidation on the surfaces of the plates, variations of temperature, and other well-known causes. Next we substituted for the copper plates two bowls containing sulphate of zinc solution with an amalgamated zinc rod in each to make connection from the galvanometer. By dipping the hands into the solution, faint indications of current were still perceived, which continued in the *same direction*, even when the hands were *reversed* in the bowls, and it was only when the liquids were intimately mixed together in a vessel, and then poured into the respective bowls again—each half of the liquid now being of the same specific gravity and temperature—that the deflection of the needle completely ceased.

This was sufficiently conclusive proof that if in our bodies there existed physiological currents forming local circuits in the nerves and muscles, as is usually supposed, there they remained, just as eddy currents circulate *inside* the cores of dynamo armatures, without showing their presence externally.

But in this instance, as in the previous case, cross-examination proved too much for the witness, as the following questions and answers show:—

Q. I will give you your choice of all the metals, so long as you have a plate of the same metal on one part of the body

which is hot, and another plate of the same metal upon another part of the body which is cool, do you produce an electric current if you connect them ?

A. Yes. In my opinion, you do.

Q. And does that describe the current in the single plate experiment that you described just now ?

A. I think it is possible.

Q. You do ?

A. I think it is. It is the $\frac{7}{10}$ths of a volt.

It is not without significance that the $\frac{7}{10}$ths of a volt, which this witness declared to be the difference of potential of the natural body current between his stomach and forehead, is precisely the same as the E.M.F. of the zinc and silvered copper couple of the belts themselves.

Only one other point, and we have done.

Two of our contemporaries complained of the attacks made upon them by Mr. Jelf, Q.C., in a matter in which they were not concerned, and in which they were not, and could not be, represented by counsel.

Our grievance is the loose and flippant manner in which certain questions were put to Prof. Horsley by the cross-examining counsel—questions which were utterly misleading, and of a nature which cannot be too severely censured. With a view, of course, to discount the Professor's evidence-in-chief, Mr. Avory put the following :—

Q. The action of electricity, as a whole, is very largely believed in as a therapeutic agent ?

A. Yes. It is agreed that certain currents are useful. Dr. Lewis Jones is an authority, I acknowledge.

Q. Are you aware that he says electricity exists in the human body in three different forms ?

A. I was not aware he had said that.

This had reference to the well known work on "Medical Electricity," by Steavenson and Lewis Jones, to which Mr. Avory was referring, and which at the time was in his hand. We have taken the trouble to see if Dr. Lewis Jones *did* say that electricity exists in the body in three different forms, and we find that Dr. Jones merely gives the views of Dr. Golding Bird, as summed up in his lectures before the Royal College of Physicians in *1847*.

And yet this, through the advocacy of Mr. Avory, goes forth to the world as the present-day opinion of Dr. Lewis Jones.

Propagation of Magnetism.

The question of the rate at which magnetism is propagated towards the inside of a mass of iron when it is acted on by a magnetising force, is a very important one, especially to makers of transformers. The unavoidable eddy currents which are induced in any plate when an alternating magnetising force is being applied, are not only sources of waste in themselves, but set up counter-magnetising forces, which oppose that which is impressed. The consequence is evident: the magnetism is prevented from getting inside the iron very far, before the opposite magnetising force is applied by the alternate current, and hence for a given mean induction in the iron, a greater force is required, and greater hysteretic losses ensue owing to the unequal distribution of the induction across the plate. These questions have been mathematically worked out in well-known papers by Professors J. J. Thomson and Ewing, but Professor John Hopkinson has been the first to put these results to the test of experiment. It is evidently impossible to work with the high frequency and small sections used in practice, but a simple relation exists between the sizes, frequencies, &c., which enables experiments on large pieces at low frequencies to give results applicable to actual practice. This work Dr. Hopkinson and Mr. Wilson have very ingeniously carried out, and their beautiful experiments bear out the results of Professor Ewing that the actual thicknesses used by makers are about right, and that $\frac{1}{2}$ mm. is the maximum thickness economical in transformers.

A Method of Compressing and Shaping Electrolytically Deposited Metals.

In a recent issue of the *Zeitschrift für Electrotechnik und Electrochemie*, 1894, p. 161, there is a special article signed by G. Langbein, in which Klein's method for dealing with electrolytically deposited metals is commented upon. This method involves the use of an apparatus which is designed for producing articles, the shape of which is that of surfaces of revolution round a central axis, and the longitudinal section of which may have any profile from that of a straight tube, for example, to that of an ornamental candlestick. The cathodes are built up on central cores which consist of strong rods or tubes coated with a layer of some easily worked substance. If they are tubes the ends are stopped with caps, and, in either case, they are provided with short axles at the ends. A core is covered, for example, with clay, and is then worked to the right form by being rolled upon a plate, the surface of which is cut in parallel ridges and hollows of the requisite form; it is then baked and finished by being again rolled under pressure on the plate, guides being used to ensure the right motion. The surface of the prepared core having been rendered conducting, it is placed in a bath of electrolyte on a glass or porcelain plate of the same shape as that on which it was formed, confronted with an anode, also shaped to correspond to it. It is then kept rolling backwards and forwards during the whole period of the electro-deposition, pressure being applied to it to any extent desired, according to circumstances. It is possible to deal with a number of objects of the same or of different shape at the same time; and the *Zeitschrift* gives diagrams illustrating various forms of the apparatus in which the cathodes are arranged side by side on the horizontal or inclined plate, and pressure and motion applied by means of a framework laid over them, provided with slots open below, in which the axles of the cores work, or in which the motion is guided by wheels rolling against the sides of the trough, while pressure is got by means of elastic pressure-rollers working against the top or against upper ledges. In other forms the plate is a vertical cylinder with horizontal ridges and depressions, round which the cathodes roll continuously as they rotate round a central vertical axis; or a flat plate with circular corrugations on which the cathodes radially disposed round a central axis, roll like the spokes of a wheel. Metal, it is claimed, can be deposited in this way, both on the inside and the outside of an annular cathode, and it is stated that it can thus be obtained in an exceedingly tough and resisting state, whilst by substituting polishing arrangements for the shaped plates, the same apparatus can be used for silver or nickel plating. The author of this paper is evidently extremely enthusiastic over Klein's process, and proceeds to dilate very minutely upon the superior advantages which it possesses over the Elmore processes. One of these he claims to be that so much more work can be done within the same space, while using the same amount of electrolytic fluid. Further, that not only cylindrical objects, such as tubes, can be made by it, but that it is equally applicable to objects which possess any profile, provided that its shape be formed by surfaces of revolutions round a central straight axis.

THE BLACKBURN ELECTRICITY SUPPLY WORKS.

The corporation electricity works are on land which forms part of the gasworks.

A report and estimates of an installation were submitted to the Gas Committee by Mr. Thomas Barton, electrical engineer and contractor of Blackburn, and on his recommendation, a low-tension direct-current system of supply was adopted.

Specifications having been drawn up by Mr. Barton for the steam and electrical plant, the contracts were placed with the following firms :—

	£	s.	d.
Boilers, steam pipes, pumps, &c., Messrs. Yates and Thom, Blackburn...	2,330	0	0
Steam engines and dynamos, Messrs. Siemens Bros. & Co., Limited, London	4,820	0	0
Switchboard, Messrs. Siemens Bros., Limited, London	770	0	0
Accumulators, the Electrical Power Storage Company, Limited, London	2,150	0	0
Cables (not including excavation, &c.), junction, feeder, connecting boxes, &c., Messrs. Siemens Bros. & Co., Limited, London ...	5,860	5	10
Stoneware insulators, Messrs. Doulton & Co., London	350	0	0
Iron culverts, Messrs. Ashton, Frost & Co., Blackburn, at 6s. 6d. per cwt.	3,000	0	0
Steel junction plates for culverts	550	0	0

The excavation of streets for laying cables, the making good, and all brickwork in connection with the feeder and junction boxes, were carried out under the superintendence of Mr. S. Ogden in a very efficient manner.

In September, 1894, the Town Council having decided to obtain further advice, Mr. E. M. Lacey, A.M.Inst.C E., of Westminster, was retained as consulting engineer to the corporation during the erection of the electric lighting installation.

In the Blackburn system there is nothing that is novel, the method being direct current and low pressure distribution on the three-wire system. The works were designed with a view to supply the principal business streets in the centre of the town, which embraces somewhat more than the compulsory area of supply.

The Boilers.

Two Lancashire boilers are at present fixed, and accommodation is provided for a third boiler, which will shortly be placed in position. The boilers are by Messrs. Yates and Thom, of Blackburn. They are 28 feet in length and 7 feet 6 inches diameter. Each boiler has two internal flues 3 feet diameter, fitted with four Galloway tubes. The boiler-mountings throughout are by Messrs. Hopkinson, of Huddersfield. The boilers are constructed for a working pressure of 120 pounds per square inch. Proctor's mechanical stokers have been fitted and are driven by a small motor supplied by Messrs. Siemens. Meldrum's furnaces have been adopted, and it is expected that by the employment of forced draught, cheap fuels, such as coke breeze, or other waste fuels, which can be obtained from the adjoining gas works, can be utilised, thus obtaining a considerable economy in steam raising. With these furnaces also it should be possible to put down fewer boilers to meet the maximum load, and in cases of emergency, they are capable of rapidly increasing the rate of combustion to meet any sudden demand for steam, such as may arise at a central station through fogs or other causes.

The water supply is obtained from the River Blakewater, or from the Corporation mains, and a storage tank has been provided, holding about 2,000 gallons. From this tank or from the river, the water is drawn by two Worthington vertical marine pattern pumps, each capable of delivering 4,000 gallons per hour, and fed into the boilers through a Berryman exhaust steam feed water heater.

The steam piping is arranged in a ring form, valves being provided to allow of any portion being cut-out without interfering with the supply to the engines. The main steam-pipes are of wrought-iron with wrought-iron flanges, the tee-pipes being of cast-iron. They are suspended from the walls of the engine house by means of rods and brackets, allowance being made for expansion. The bends and branches to the engines are of copper. Suitable arrangements are provided for draining the sections of the steam-pipes.

The main exhaust pipe is of cast-iron, 12 inches diameter, branches being provided for the purposes of forming a way either through or by the heater.

Steam Engines and Dynamos.

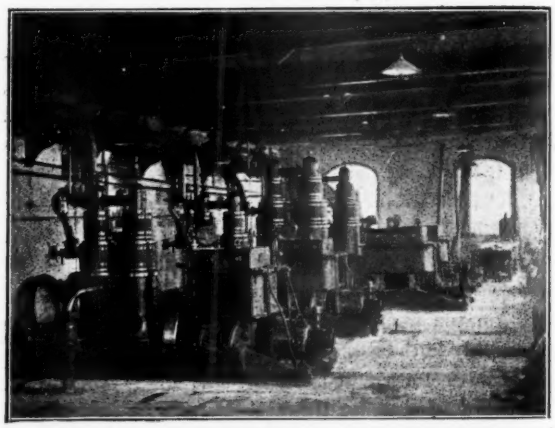
Four compound engines of the Willans patent central valve type have been put down, the dynamos being mounted on the engine bed-plates and direct driven.

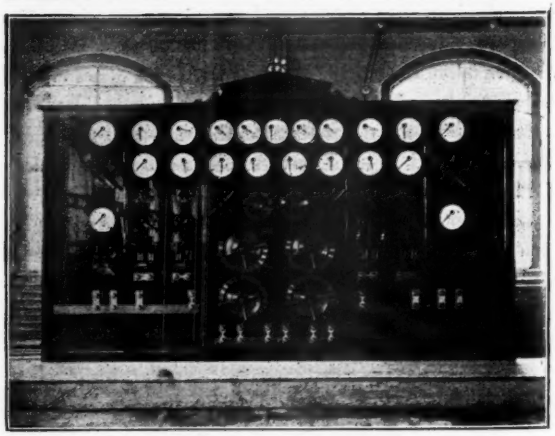
Two of the engines are Messrs. Willans's I.I. type, and the other two are their G.G. type,

The dynamos are by Messrs. Siemens Bros., and are of their usual central station type with drum armatures, the field coils being shunt wound. The two larger machines have each an output of 500 ampères and 240 volts, with a speed of 330 revolutions per minute, and the two smaller machines each have an output of 300 ampères and 150 volts, with a speed of 450 revolutions per minute.

The engine and dynamo plant has been put down to meet the requirements of the current supply for the equivalent of 10,000 8-C.P. lamps installed.

General View.





View of Switchboard.

Accumulators.

These consist of 120 cells, each containing 87 "K" type plates made by the Electrical Power Storage Company. The cells are capable of giving a discharge of 300 ampères for 3½ hours, or on an emergency are capable of discharging 850 ampères for one hour. The containing boxes are of lead with insulated bottom, and provided with lips to prevent electrical leakage due to creeping of acid. The cells are placed on varnished wood trays on glass oil insulators.

The switchboard consists of five panels of enamelled slate. On the centre panel are placed the battery regulating switches, the battery ammeters, voltmeters, and two four-way switches for the small dynamos, so that either of these dynamos can charge on to either side of the accumulators.

At the top of the centre panel are placed the feeder volt-

meters. The panels on either side of the centre panel contain main automatic cut-out and shunt switches, regulating switches, ammeters, and voltmeters for each dynamo. On the outer panels are placed the main switches and ammeters for the feeders. On these panels also the feeder regulating switches will be placed.

The dynamos and accumulators are brought on the switchboard to omnibus bars which are capable of being regulated to any required difference of potential, and from these bars feeders are taken to the feeder points. Each feeder will be provided with additional independent regulation by means of regulating switches and counter E.M.F. cells.

The output of the station is measured by means of Thomson's watt-hour meters attached to each feeder.

The whole of the switches, instruments and apparatus, on the board, were made and supplied by Messrs. Siemens Bros., Limited, Mr. Vincent being in charge of the erection for that firm.

The Cables.

The cables have been supplied by Messrs. Siemens Bros., of London. They are very highly insulated with pure and vulcanised rubber, and have been laid on stoneware insulators in iron culverts. At present the feeders from the station on to the distributing network are only two in number, each having a cross sectional area of ·8 square inch for the outer cable, and ·5 square inch for the inner. The cables for the distributing network are of three sizes, having cross sectional areas of ·5, ·3, ·5 square inches; ·4, ·3, ·4 square inches; and ·25, ·2, ·25 square inches respectively.

The tests taken before any house services were connected up came out at over 1,500 megohms per statute mile, a matter of considerable credit to the contractors, taking into consideration the difficulties they had to contend with. Mr. Horn, A.I.E.E., was in charge of this work for Messrs. Siemens Bros.

The services to consumers are vulcanised rubber cables laid in iron pipes. These services are carried to terminals immediately within the consumers' premises, at the expense of the Corporation, provided that the distance from the mains does not exceed 60 feet.

Public Lighting.

The public lighting already sanctioned consists of four arc lamps at Sudel Cross, two arc lamps in front of the Town Hall and two in front of the Market Hall, also two on Salford Bridge and two at the corner of Church and Darwen Streets, making 12 lamps in all. They are made and supplied by Messrs. Siemens Bros., and are arranged on standards furnished by Messrs. McFarlane & Co., of Glasgow.

Private Lighting.

Distributing mains have been laid and a supply of electrical energy is available in Church Street, Darwen Street, Lord Street, New Market Street, King William Street, a portion of Preston New Road, Richmond Terrace, Library Street, Exchange Street, Victoria Street, &c.

Already upwards of 3,000 lights have been applied for and this does not include the Town Hall, Municipal Offices, &c. Further applications are being received, and it is hoped that the present station will soon be working at its full capacity.

The members of the Gas Committee of the Corporation are:—The Mayor, Aldermen Rutherford, Wm. Thompson (Chairman), Boothman, Coddington, Harrison, Dugdale, Whiteley, John Dixon and Hoyle (Vice-Chairman), Councillors Eccles, J. E. Sharples, Pollard, Crossley, Walsh, Oddie, Whiteley, Jas. Sharples, J. Law, Kenyon and Hamer.

The chairman of the committee, Mr. Alderman W. Thompson, has spared neither time nor trouble to make the undertaking a complete success.

The town clerk, Mr. R. E. Fox, also rendered most valuable service, having personally dealt with the whole mass of correspondence, the preparation and execution of contracts, and numerous other legal and business details during the whole course of the carrying out of the work, and it has been of great advantage to the Gas Committee to have had the benefit of such advice and experience at instant notice, such as Mr. Alderman W. Thompson and the town clerk were able to contribute.

ON A PROPOSED MODIFICATION OF THE GENERALLY ACCEPTED TEMPERATURE CO-EFFICIENT OF RESISTANCE FOR COPPER WIRES.

By A. E. Kennelly and Reginald A. Fessenden.

In a paper entitled "Some Measurements of the Temperature Variation in the Electrical Resistance of a Sample of Copper," read at the International Electrical Congress at Chicago, 1893, and also published in the *Physical Review*, Vol. i., No. 4, page 260, the authors showed that the temperature coefficient of resistance at any temperature ($t°$ Centigrade) of a sample of good commercial copper wire, which appeared by chemical analysis to have a high degree of purity, could be very closely represented by the formula,

$$\rho_t = \rho_0 (1 + 0{\cdot}004065\, t) \qquad (1)$$

Recent determinations by Messrs. Dewar and Fleming and Messrs. Swan and Rhodin, concur in giving a linear relation between temperature and resistance.

As the results of measurements made to determine the temperature coefficient in annealed copper wire, we have for the range from 0° to 100° C., assuming a linear relation, as follows:—

Benoit...	·373
Cailletet and Bouty	·425
Matthiessen	·422
Siemens	·388
Dewar and Fleming	·424
Kennelly and Fessenden	·406
Swan and Rhodin	·415
We obtain as the mean	·4076

We therefore suggest that since the exact temperature coefficient is not yet determined, and since it may possibly vary in different samples of copper in commercial use, that the simple formula,

$$\rho_t = \rho_0 (1 + 0{\cdot}004\, t) \qquad (2)$$

may be accepted provisionally for all practical purposes, or in other words, that the resistivity of copper be considered to increase by 0·4 per cent. per degree Centigrade of temperature elevation, reckoned from the resistivity at zero Centigrade.

Should the corrected coefficient be subsequently determined to be 0·0041, formula (2) would become

$$\rho_t = \rho_6 [1 + 0{\cdot}004\, (t - 6)] \qquad (3)$$

ρ_6 being the resistivity at 6° C.

Similarly, if the coefficient subsequently accepted should be 0·0042, the corresponding formula would be

$$\rho_t = \rho_{12} [1 + 0{\cdot}004\, (t - 12)] \qquad (4)$$

ρ_{12} being the resistivity at 12° C. and for an accepted coefficient of 0·0043,

$$\rho_t = \rho_{17{\cdot}5} [1 + 0{\cdot}004\, (t - 17{\cdot}5)]. \qquad (5)$$

Consequently, if we adopt equation (2) at the present time, we obtain, pending more exhaustive enquiry, a formula much simpler, more convenient, and probably more nearly accurate than that of Matthiessen, while any future correction can only have, it would seem, an influence upon the standard or datum temperature, and a comparatively trivial quantitative effect within ordinary temperature ranges.

ELECTRIC LIGHTING FOR CARRIAGES.

In a recent report to the State Department C. W. Chancellor, the United States Consul at Havre, France, makes some pertinent remarks concerning the lighting of carriages by electricity. He says:—

"Gas lighting, which was common in London as early as 1810, was not introduced into Paris until 1819, and more than twenty years elapsed before its use as an illuminant became general in France. On the other hand, when we turn to the subject of electric lighting, it must be admitted that France has taken a foremost rank among European nations in adopting the electric light.

"In Paris, electrically lit private carriages have, for the last five years, been extensively patronised by the affluent classes, but only recently has this process of lighting been applied to private carriages in London and Berlin. The Prince of Wales was the first to adopt it in London, and now we learn that the German Emperor has brought the resources of his active mind to bear on the subject of lighting carriages, and, as a consequence, the court carriages in Berlin are now lit by electricity, not only by outside lanterns, but also in the interior, which is illuminated by a series of accumulators carried in the vehicles. All over the harness are placed what the Germans call Glühlampen, or small, coloured lights, which glow like fireflies when the carriage is in motion."

It is obvious, says the New York *Electrical Engineer*, that the adoption, on an extended scale, of electricity as an illuminating agent in private and public vehicles would serve a double purpose—first, one of a distinctly practical usefulness; next, that of increasing the brightness and cheerfulness of the streets, which would materially aid in the beautifying of a city. Again, it has been ascertained that the more the omnibus and street car companies make their vehicles attractive, the greater will be their traffic.

In private carriages, the electric lamp is placed inside, in the centre of the roof, and the flat twin lamps are shielded by a circular glass plate rather larger than the "bull's-eye" of any ordinary searchlight. At the back of the lamp there is a dome or bell-shaped enamelled reflector. In order to economise space, the flat lamps are not hung vertically in the bell protector, but lie horizontally, and in order to prevent the filament from drooping when hot, a little glass anchor is added to support them. In this way the roof of a brougham is fitted with a light diffuser which will not interfere with a person's head entering the vehicle. Each of these lamps gives a light equal to 7 candles.

In the first attempt to light carriages in this manner the moving of the carriage was apt to jar the lamps, often causing a breakdown, and steel springs were not found sufficient to prevent this. The plan now adopted is to suspended the complete lamp in a sheet of rubber, which is attached to the interior of the carriage, neutralising the vibration. It is only necessary to press a button in order to switch the current on, and by a second push it is turned off again.

A sufficient supply of electricity required for the lamp is stored in an accumulator. One accumulator, weighing 2 lbs., is the allowance for each lamp. Should the two outside lamps be also electric, two additional batteries would be needed. The accumulators are carried in the boot, under the coachman's seat, and are easily accessible. The coachman himself, without electrical knowledge, makes the necessary connections.

An eight-cell storage battery, for an ordinary family carriage or brougham, is contained in a box 8 inches long, 4 inches wide, and 7 inches deep. This supplies the current to keep the lamp lighted for 18 hours, which, ordinarily, is sufficient to last the owner of the carriage from one to two months. The cost of recharging varies from 50 cents to $1 —not more than the expense entailed by the employment of oil lamps, which invariably give out an unpleasant odour, and an uncertain illumination. The electric lamp does not wear out unless subjected to careless treatment, or unless it is weakened by the application of too strong a current. The accumulator, however, makes the latter contingency almost an impossibility.

There appears to be a fair prospect that, in the course of a few years, the majority of public conveyances in cities, as well as private vehicles, will be lighted by electricity; but the public will, of course, expect that electric lighting shall be superior to oil. This question seems to have been already quite well determined. It has been found that an electric lamp of 2½ candle-power will enable any passenger to read in comfort while travelling. Apart from the actual amount of light to be afforded, which, of course, is capable of adjustment, it may be stated that the latest form of battery overcomes the difficulties which have hitherto stood in the way of the adoption of electricity for the lighting of street conveyances.

A street car battery, working two lights to illuminate the interior as well as the coloured signal lamps, will weigh about 30 lbs., and furnish a light, equal to 2½ candle power, for from 45 to 50 hours.

Lamps applied to omnibuses, street cars, and cabs differ in form. The omnibus light is fixed in a globe, smaller and flatter than the pattern which screws the oil lamps in an European railway carriage. Behind the lamp is a concave reflector of enamelled iron. There is no restriction as to the form of the street car lamp, as the same conditions do not apply; but in the cab lamp, where economy of space is a consideration, the globe, contained in a semi-circular reflector, having a glass front, is placed upright at the back of the vehicle, over the passengers' heads. The cost of such installation, including the accumulator, is about $50.

REVIEW.

American Electric Street Railways: their Construction and Equipment, with Notes as to the cost of installation and of maintenance. By Killingworth Hedges, M. Inst. C.E, M. Inst. E.E. E. and F. N. Spon, 125, Strand. 205 pp. 4to, illustrated.

While Mr. Hedges's book does not profess to be more than a description of American electric railway practice as he saw it during a late visit to the United States and Canada, it is certainly a most commendable addition to the literature upon a subject especially interesting at the present time, both to the public at large and the electrical profession. The author has treated his matter in a quasi-popular vein, and has attempted little in the line of abstract discussion of the principles concerned, devoting his pages almost exclusively to a description of the various types of apparatus employed, the tramway systems visited by him, and the economic results so far attained in America from the wide-spread introduction of electrical traction. The book is profusely and handsomely illustrated throughout, and can be understandingly read by those unacquainted with electrical and engineering technicalities.

Track construction does not receive the attention which its importance warrants. Rail-bonding is well treated, and very interesting tables of the resistance of return circuits, compiled by American authorities, are quoted at length. It would seem that more space could advantageously have been devoted to the interesting experiments of Mr. Farnham, of Boston, which have conclusively demonstrated that by the use of modern appliances and precautions, all danger from electrolysis is avoided.

Overhead line material and construction are fully described, and instructions given for proper erection of the trolley-wire and its accessories.

The conduit system which was abandoned at Chicago and is now in experimental use at Washington, is described and illustrated at length, as well as the similar system introduced by Messrs. Siemens & Halske at Budapest. The feasibility of electrical operation by means of conductors below the street surface, has never been doubted. It has always been the financial test to which it has failed to favourably respond. The general consensus of opinion undoubtedly is that where traffic is sufficiently great to warrant the heavy capitalisation required by a conduit installation, the cable is more efficient and economical than electrical power.

Motors and their accessories are fully described, and we are glad to see that the author has not considered it essential to embody those ancient forms which have now only an historic interest.

Exceedingly interesting matter relative to railway generators and switchboards and their erection and maintenance is quoted from the instructive pamphlets issued by the General Electric Company, U.S., to their customers, and to engineers in charge of installation work.

Chapter IX. is mainly quoted from the report on engines and power-house plants submitted to the American Street Railway Association at its convention last year.

Direct coupled vertical high speed engines do not seem in high favour in the United States, although slow speed vertical and horizontal direct coupled engines are much used. In this, American and Continental practice agree.

The following figures are extracted from an elaborate table given by Mr. Hedges, as showing the economy resulting from the use of high speed engines.

Type of engine.	I.H.P. required to produce 500 H.P. on shaft.	Total cost in £ per I.H.P. of engine, boilers, and buildings.	Combined efficiency of engines, generators, and line.	Cost of E.H.P. hour on line if coal costs 8/- per ton, in pence.	Cost per year of taxes, insurance, and maintenance per. H.P. on line in £.
Triple expansion high speed condensing ...	542	10·97	77·2 %	0·115	1·14
Triple expansion low speed condensing ...	556	13·45	75·3 %	0·104	1·30

From these figures it would seem that in large plants, or where land is expensive, the interest on the larger capital necessary for high-speed installations would, in many cases, overbalance the apparent saving in coal to be obtained by employing low-speed plant.

The following figures from Mr. Aldrich's report to the Street Railway Association, are also given :—

Engine.	Connection.	I.H.P. delivered by engine.	E.H.P. delivered by dynamo.	Total friction in H.P.	Per cent. total friction in H.P.
Triple-expansion condensing Corliss.	Countershaft and friction clutches.	756	624	132	17·40
Compound high-speed Westinghouse.	Belted direct.	522	434	88	16·90

The coal conveyers so largely used in Brooklyn and the forced draught apparatus which is working on a large scale in Philadelphia, might with advantage have been gone into more fully.

Little is said of operation methods. This is to be regretted, as this question is of vital importance, and has been most carefully worked out in America since the introduction of electrical traction, many new features having been introduced. Moreover the American and English systems differ widely, and an interesting comparison might have been instituted between their respective advantages and disadvantages.

Some important American power plants are described at length, accompanied by full specifications and dimensioned drawings.

The following figures are quoted by Mr. Hedges :—

Name of line.	Ratio of working expenses to receipts.	Total working cost in pence per car mile. Interest on capital alone excepted.
U.S.A., Kansas City elevated electric	...	6·49
„ Pittsburgh, Pa.	71·1 %	6·12
„ Chicago, Ill.	40 %	6·80
„ Rochester	48·62 %	5·53
England, Liverpool overhead ...	73 %	4·35
„ City and South London	64 %	5·31
„ Bessbrook-Newry ...	...	3·97
„ Guernsey, Channel Isles	54·45 %	6·22
Germany, Halle	54·50 %	2·62
„ Frankfort-on-Main ...	70 %	4·60
Switzerland, Murren	50 %	4·00
France, Marseilles	60 %	6·68

We think it may be of interest to compare these figures with some prominent English horse tramways :—

Name of line.	Ratio of operating expenses to receipts.	Total cost in pence per car mile.
All London tramways ...	82·7 %	9·8
Birmingham Midland ...	81·22 %	13·72
Birmingham Central	76·79 %	9·96
Dublin United	73·80 %	9·77
Dundee	73·75 %	10·78
Leicester	83·78 %	9·80
Sheffield	79·85 %	9·95
Newcastle and Gosforth ...	90·51 %	11·25

From Duncan's Tramway Manual for 1893 we take the following summary of 73 English horse lines :—

Number of lines.	Ratio of operating expenses to receipts.
14 lines	75 per cent. to 80 per cent.
13 „	80 „ „ „ 85 „ „
13 „	70 „ „ „ 75 „ „
8 „	90 „ „ „ 95 „ „
8 „	85 „ „ „ 90 „ „
4 „	95 „ „ „ 100 „ „
4 „	65 „ „ „ 70 „ „
4 „	60 „ „ „ 65 „ „
2 „	100 „ „ „ 105 „ „
2 „	55 „ „ „ 60 „ „
1 line	40 „ „ „ 45 „ „

And from the same authority the following summary of 45 English horse lines :—

Number of lines.	Working expenses in pence per car mile.
14 lines	8d. to 9d.
12 „	9d. „ 10d.
8 „	10d. „ 12d.
5 „	12d. „ 14d.
3 „	7d. „ 8d.
2 „	6d. „ 7d.
1 line	5d. „ 6d.

The average ratio of operating expenses to receipts in per cent. for all the tramways in the United Kingdom was, according to "Duncan's Manual" of 1893, over 80 per cent.

A comparison of these figures with those given by Mr. Killingworth Hedges, both for America and the continent, would seem to show the great advantages of electric over animal power.

Electric Light Installations. By Sir David Salomons, Bart., M.A. London : Whittaker & Co. Three volumes.

Volume I. treats of lead accumulators, and describes the well-known forms. The descriptions are clear and correct, and convey a good notion of the construction of the various cells, their setting up and handling, charging and discharging. As a popular treatise for intending purchasers or present users of storage batteries it is an excellent book.

There is little or no attempt at scientific treatment of the subject; the introductory chapter briefly passes over the whole ground of electric light installations. The rest of this volume is devoted to the storage battery entirely.

Volume II. deals with apparatus used in installations, and treats the subject much in the same way as an illustrated catalogue, the illustrations showing merely the external appearance of the apparatus. Some of the apparatus might with advantage be left out as obsolete. On page 100, fig. 56 shows an ammeter, the author stating that "This is illustrated because it is the simplest possible form of ammeter, and is rarely used." Then why waste space on it? Besides, it certainly is not the simplest possible form.

In motors the only one prominently placed is the Crocker-Wheeler. Possibly it, also, is described and illustrated because "it is rarely used." It would not be difficult to find many British made motors of far better design electrically.

The cases said to contain transformers are elaborately illustrated, with eye bolts as the prominent features; the cast-iron case of a Brush transformer looks very grand, but as to what is inside of it the reader is left to his imagination. The rest of this volume consists of brief outline description of apparatus from makers' catalogues. Altogether, it is a volume of little use to anybody.

Volume III. treats of "Applications." It begins with "Precautions," warning intending electric light users against going to work without skilled advice. A word of warning is required also against the employment of incompetent inexperienced advice. The author illustrates his views by instancing the architect in the building of a house, but no architect takes his instructions or looks for plans from the builders. Many electrical consulting engineers place all the engineering upon, and get all plans from, the manufacturers, so that

the client requires to be warned, not only against working without advice but also against falling into the hands of the incompetent.

Three rules for insulation resistance are here given. The first one, said to be that of the Institution of Electrical Engineers, is wrong entirely. The author gives this rule as:—Multiply 7,900 by volts employed, and divide by number of lamps; result will be insulation in ohms required. This is not the rule at all. The 16th rule of the Institution of Electrical Engineers states that "The greatest leakage shall not exceed $\frac{1}{5000}$th of the total current."

The other two rules—the Phœnix Fire Office, and Prof. Jamieson's—are given correctly, both taking the number of lamps as a divisor—a practice which is rather slipshod, without defining the "lamp."

Again, the author states that the Electrical Engineers' rule is not bad, because it gives for 200,000 8-C.P. lamps a total leakage of 25 ampères. That may be according to the wrong rule given, but by rule 16 of the Electrical Engineers the total leakage ought not to exceed 12 ampères in this case, so that the right rule is better even than the wrong one.

This volume, on the whole, will be interesting reading to people who wish to get a general idea of electrical engineering. It concludes with some wild speculations regarding ether, the existence of life, and the Divine origin of everything, one of the speculations ending with this sentence:—"There is no reason why a man should not be dissolved in a bath in England, and be re-deposited in America, provided the first *impulse* can be given." No doubt we shall then be able to send people across the herring pond through pipe lines, ocean passenger steamers becoming a thing of the past. The author is not sure, however, whether the body re-deposited would be dead or alive, and as men, according to Sir David, are merely instruments played upon by ether, he speculates as to whether there is a future life, and rather inclines to believe there is, winding up a most extraordinary aberration from the work in hand by imagining the time when men, and, perhaps, women too, will be able to read each other's minds perfectly clearly, speech will no longer conceal our thoughts, and truth and justice alone shall prevail.

From these lofty metaphysical heights we are dashed down at once to the glowing pit of vacuum tubes. Sir David thinks that by studying them we may yet find out really what electricity is.

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*On Two Graphic Methods for the Enumeration of Beats, and on a Microphonic Capsule.** By Dr. Filippo Campanile.

It is admittedly important to have an exact knowlege of the beats produced by two sounds; in acoustics for the determination of the pitch of such sounds, and for the measurement of the musical interval; and in music in order to bring two sounds into unison. If we call N′ and N the number of vibrations executed in a second by the two sounds, and I the musical interval and B the number of beats resulting in a second, we have the relations:

$$I = \frac{N''}{N} \qquad (1)$$

$$B = N' - N. \qquad (2)$$

The expressions 1 and 2 enable us to find N′ and N when we know I and B, and (2) alone gives us the means of determining one of the numbers of vibration if we know the other one and B.

As in the first so in the second case, the problem easy to solve in theory is not so easily solved in practice. The number of beats may be readily determined when the difference between N′ and N is small, but in such a case it is most difficult to estimate the interval I and *vice versâ*. Scheibler to obviate this great difficulty constructed the apparatus which he has called *tonometer*.

Certainly for the enumeration of isochronous movements the graphic method is that in which we may have the greatest confidence. Now, for all the many researches which the author has made, he has found no method for obtaining the simple graphic enumeration of the beats generated by two sounds. He has studied the question in order to find a method for knowing accurately the number of beats, rapid or slow, and he gives in this research the methods found which solve the question.

A first method is applicable to the determination of the number of beats produced by two sounding pipes, or a pipe and a singer; a second method is applicable, also, in the case of two tuning forks, and is more general and much more sensitive.

General Principle.—If the sound waves produced by two sounds are caused to arrive into a single tube of caoutchouc, at each superposition of the movements in the same phase of vibration, the sound will be strengthened, and it will be enfeebled when the sounds are superimposed in the opposite phase. These reinforcements and weakenings of the sound produced by two sounding bodies, constitute the beats, and the resulting variations of the pressure of the air in the tube may be shown by the methods which he describes.

1*st Method.*—The tube in which the sound waves are collected communicates with a Marey drum, and the variations of the pressure of the air suffice to set the membrane of the drum in vibration. At each reinforcement or enfeebling of the sound produced by the two sonorous bodies, the air thrusts forward the membrane of the drum, and at each enfeebling impress upon it a movement in the opposite direction. These movements are transmitted to the finger which oscillates, and each complete oscillation corresponds to a beat of the two sounds.

2*nd Method.*—In this method the variations of the pressure of the air produce the displacement of the membrane of a capsule which he has devised and constructed, and which he has named the microphonic capsule.

The full explanation of the structure and the applications of this capsule, and which takes the place of Marey's drum, requires a number of illustrations.

* Vol. vii., Series 2, No. 4, of the *Transactions* of the Royal Academy of Physical and Mathematical Sciences of Naples.

Electrical Engineering as a Profession. How to enter it. By A. D. Southam. London: Southam & Co.

This work professes to be a guide to those desiring to become electrical engineers, or more grandiloquently put, "To enter the electrical engineering profession." It seems there is some strong impulse driving hundreds of young men into the "electrical engineering profession;" what becomes of all of them heaven only knows. In the book before us the various methods of, and places for, the training of future professional electrical engineers are fully and carefully described, and the information is correct and valuable. But just where any assistance as to "How to enter it" can be given by this book we cannot find. It is one thing to know how to prepare for a profession but quite another to enter it, especially when, as is the case in "the electrical engineering profession," it is full to overflowing. Works like this might, with advantage, teach that, while the professional classes are overflowingly full the skilled workman classes are scantily supplied; and that it is a remarkable fact that many leading men have entered the profession not as professionals at all, but as skilled workmen.

This book divides engineers into three classes only, consulting, contracting, and manufacturing. But where does the manager of a power house for electrical supply come in? He belongs to neither, and yet it is the only branch beside consulting into which the professionals largely enter. This book also shows how advantage is taken of the craze for electrical engineering as a profession by many firms drawing large incomes from premium apprentices.

ATMOSPHERIC ELECTRICITY.

Prof. Schuster delivered a discourse on "Atmospheric Electricity" at the Royal Institution last Friday evening. He prefaced his remarks by discharging a couple of Leyden jars, stating at the time that everyone who saw such an experiment must have been struck with the similarity between the spark discharge and lightning. Although Benjamin Franklin was not the first to perform the experiment, he was the first to show by definite means the relation which existed between electrical discharges in the atmo-

sphere and the discharge of a Leyden jar. One of the experiments suggested by Franklin in 1749 was the erection of an arrangement resembling a sentry box on the top of a high building; in this a man was to stand, being insulated on a glass-legged stool, and grasping a rod projecting skywards. Another individual, in connection with earth, was then to see if sparks could be obtained on bringing the knuckle of his hand near any part of the body of the animated lightning conductor. It is not apparent that Franklin anticipated any dangerous results from this experiment; at any rate we have no record that any such occurred. Although the thunderstorm is one of the best known examples of atmospheric electrical disturbance, it is by no means the only one.

To explain the theory of electrical discharge, according to modern ideas, the lecturer took a piece of elastic, and holding one end in each hand, pulled it out. His two hands then seemed to attract each other, due to the material under stress connecting them. In this way the modern theory of electricity, as expounded by Lodge and Rowland, was brought home to the habitués of the Institution in Albemarle Street. Although it is difficult to get rid of the idea of electricity "as a something," it is better to consider that it is not a something itself, but the manifestation of a something in between the charged bodies, which is under a stress or exhibits results of the nature of a stress. If the string or elastic referred to, broke, then the analogy with an electric spark is complete. The something which breaks down cannot be ether, because if the air is got rid of no spark would pass; the weak part of the chain has evidently some connection with air.

Atmospheric electricity had been noticed by observers from comparatively early times. It is especially marked in fine weather. The changes in intensity are shown in fig. 1, in

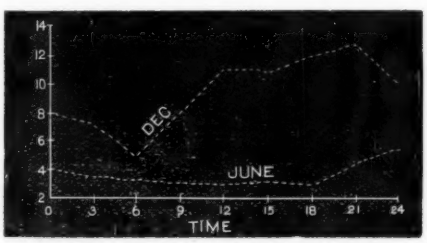


Fig. 1.—Curve Showing Diurnal Variations for Winter and Summer.

which the diurnal variations are shown, as well as average curves for winter and summer. One of the earliest records of observations was made by an experimenter to whom the ether-stress was evidenced by his hair standing on end, and he, in the true spirit of a scientific man, not only recorded

Fig. 5.—Curve Connecting Stress with Aqueous Vapour Pressure and Solar Radiation in the Ultra-violet.

the fact, but also the length of hair which stood on end: it was 4 inches. Prof. Schuster gave an illustration of the average field of force which is found at an ordinary height, by inserting a bank of lamps between two horizontal plates. These were apparently 100-volt lamps, and lit up brightly. Although in this experiment the analogy was complete, in practice the difficulty is to obtain measurements, because the bringing in of a body into the charged space disturbs the electrical field.

The question which is asked as soon as it is appreciated that lines of force start from the surface of the ground is, where do they end? There is a theory that the lines of force pass outside the earth, and that the earth has been electrified for all time, but several causes are at work which, it is known, would tend to de-electrify it, should the foregoing theory as to initial electrification be accepted as true. Franklin was aware of the fact that heated air would conduct; the experiment is a common one, and Prof. Schuster repeated it by using an electroscope of aluminium foil leaves; these were caused to diverge by being charged, and on bringing a lighted match near them they collapsed. The lines of force gave way as soon as they passed through the flame. Electrified air discharges a charged body, and will not carry lines of force. These two facts were strikingly exemplified by the apparatus shown in figs. 2 and 3 respectively. In fig. 2 an insulated retort stand carries a Bunsen burner,

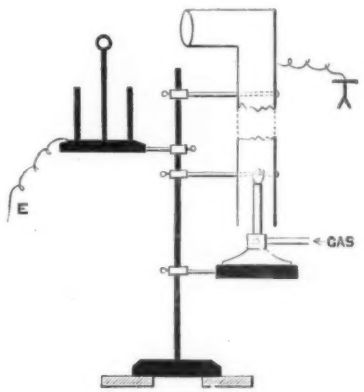


Fig. 2.—Apparatus to Demonstrate that Heated Air will not Carry Lines of Force.

which is lighted, and the products of combustion and heated air pass up the stove pipe in which the flame is set. The pipe has its upper end so placed that the heated air is discharged upon, or in the neighbourhood of, the knob of a charged Leyden jar, also carried by the stand. The burner, pipe, and Leyden, are insulated at the points of support, the pipe being connected to an electroscope, and the outside coating of the Leyden (to use Lord Kelvin's short term) is earthed. The electroscope does not, under normal circumstances, indicate the presence of a charge, but when the Bunsen burner is placed in position and the gas is ignited, it at once diverges, and on being discharged the leaves fall back only to rediverge, and so on. This shows the conductivity of heated air very clearly.

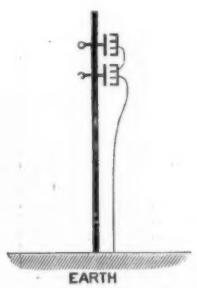


Fig. 4.—Lightning Protectors at Pontreschina.

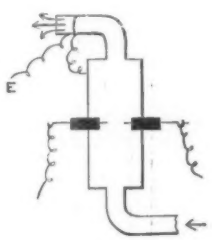


Fig. 3.—Spark Gap.

The second experiment is not quite so well known, and was quite as successful. In fig. 3, the spark gap of an induction coil is shown. The two spark pieces are connected to the secondary terminals of an induction coil, which, with the battery and spark gap, were at the Royal Institution covered by an earthed metallic case. Leading to and from the spark gap are two pipes, one is connected by rubber tube to a small foot blower, and the other was brought out opposite the knob of a Leyden. The Leyden was charged and connected to a lantern electroscope. On working the blower no marked effect was produced, but as soon as the coil was set in action, and the air through which sparks had been passed

was caused to impinge upon the knob of the Leyden, the electroscope leaves fell together, showing that air in this condition was also conducting. Prof. Schuster then remarked that this effect was shown on a large scale at Pontreschina, where the electric lighting mains were run overhead, and being in a mountainous district addicted to thunderstorms, were protected from lightning by dischargers as indicated by a wall diagram reproduced in fig. 4. When minute sparks passed across the air gap of the discharger the dynamo current followed, and, according to the speaker's experience, this led very often to a complete shut-down of the lighting system. Sometimes the supply was resumed in a few minutes, at other times station plant was damaged, and an interruption took place lasting some time. We were under the impression that this fact was fully appreciated by electrical engineers, and that the Thomson-Houston, Westinghouse, and other manufacturers supplied dischargers arranged to free a system from excessive static charge, without permitting lightning to lead over the dynamo current. Mr. Wurts's recent work on this subject is pretty well known, and his latest recorded results show that an experimental demonstration of the breaking down of air need not be made at the cost of electric lighting companies.* The effect of heated air in conducting a discharge away harmlessly to earth, may be taken to explain the immunity enjoyed by factory chimneys from damage by lightning.

To answer the questions, Where do the lines of force end? Do they reach out to the other planets, or are they limited to the atmospheric envelope of this globe? Balloon and kite experiments have been made up to heights between 10,000 and 20,000 feet. Electrification apparently vanishes at a height of 12,000 feet, according to a recent carefully conducted experiment. Investigations of a like kind have shown that the diurnal variations which take place are uniform over the earth. These are stronger in winter than in summer. Some recent observations at Vienna, and others made by a friend of Prof. Schuster during a voyage round the world, have led to some most interesting conclusions. It appears that the electrification of the atmosphere is connected with, not the amount of watery vapour in the air, but the aqueous vapour pressure. Fig. 5 shows a curve, one of four exhibited, connecting the volts per cm. with the vapour pressure. It is more important, however, to find that a curve, deduced from the latter observer's measurements, plotted over the theoretical curve and connecting solar radiation with electrification, shows only small departures from the theoretical. If this be confirmed, then it follows that a more important relationship will be found to exist; some connection between the ultra-violet solar radiation and the amount of moisture in the air. Atmospheric electricity can therefore be best investigated by examining these effects.

The lines of force seem to find their anchorage on small

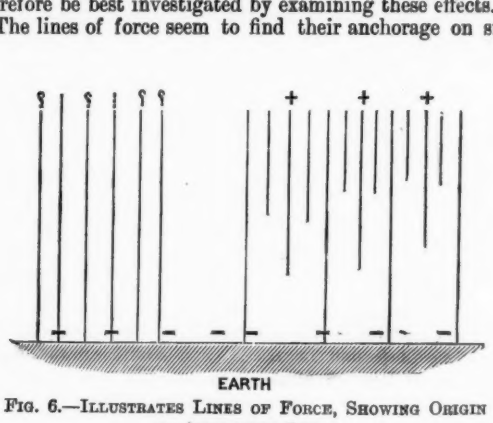


Fig. 6.—Illustrates Lines of Force, Showing Origin of Additional Lines.

masses of matter. Dust storms are known to exercise an influence upon the sign and magnitude of electrification at different points. Thus a dust storm in Upper Egypt seemed to reverse the electrical effects in the centre of Germany. Waterfalls cause a redistribution for many miles around, and no useful observations can be taken in a valley in which there are waterfalls. Figs. 6 and 7 show two diagrams used to illustrate the lines of force in direction and magnitude. Fig. 6 shows the principle upon which the increased electrification above the surface of the earth may be explained; the earth being — and a number of lines of force starting therefrom; above this further lines have their origin, and higher still, more. "The lines of force start upwards; we do not know where they end." In fig. 7 the action of a dust cloud in reversing the sign of electrification is shown; here the dust in connection with earth causes the generation of lines, which fall back to the earth, and therefore appear to be of + sign.

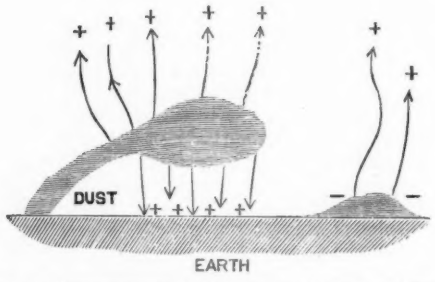


Fig. 7.—Illustrating Reversal of Lines of Force due to Dust Storm.

The thunderstorm is a rather violent cure for the diseased state of nature, when her nervous system is out of order. There are two kinds of thunderstorms, one which occurs on the edge of cyclonic disturbances or eddys. A thunderstorm of this kind is broken up in crossing a river, and may travel down one bank before breaking up. There is a great regularity in their behaviour, and in the paths of discharge. Thus of trees the oak is frequently struck, but the beech never, or very seldom. Oily matter seems to be a peculiar protection against lightning, and this may explain why the latter is exempt. In a thunderstorm the safest course for a human being is to get wet through to begin with. Franklin has recorded that he could kill a rat when dry by a lightning discharge, but when wet, never. Prof. Schuster exhibited the stocking worn by a friend of his while Alpine climbing; in it a large hole had been burnt, but without bodlly harm to the wearer. This was due to a discharge received through the body which, however, left no mark. The exact manner in which the mishap occurred was, however, not dwelt upon. St. Elmo's fire is another interesting evidence of atmospheric electricity, its sign may be either + or —. Some of the Pontreschina breakdowns were stated to have been traced to this source, the actual thunderstorm being absent.

Between 1753 and 1886, 25 theories of atmospheric electricity have been proposed. The most fruitful year was 1884, when no less than five brand new theories appeared. The favourite causes cited are the earth's rotation and the energy radiated by the sun. The evaporation which goes on from all large bodies of water due to the heat of the sun is usually regarded as a leading cause. Prof. Schuster then illustrated the difficulty which attaches to certain problems; this may be summed up in the short question, how can we get into a sphere? Lenard's experiments on artificial waterfalls and the electrified air round a waterfall were mentioned. The fact that a cloud discharges rain during an electrical excitement has a bearing on the same question. Faraday found, for example, that ice and water rubbed together left a state in which the ice was positive and the water negative. Where clouds lie above a thunder cloud, it may be suggested that ice and water are practically in layers, and mutual friction will give rise to the separation of electrical charges.

The aurora borealis was the last manifestation of atmospheric electricity alluded to. This is, in England, usually seen at a height of 100 to 200 miles, but in Arctic regions much lower. The borealis is usually connected with the formation of cirrus clouds, and it appears regularly with the long cycle of eleven years. Its appearance, and the occurrence of spots on the sun, have been noted as taking place together. It is at a minimum in Greenland when at a maximum with us, and this appears to indicate that the belt

* *Vide Electric Power*, February, 1895. "Notes on Protection against Lightning," collected during the summer of 1894, by Alexander Jay Wurts.

favourable to its display suffers a displacement. After a brief reference to inter-planetary effects and diurnal variations, Prof. Schuster closed a most instructive discourse by expressing a hope that as another Antarctic expedition was being talked about, those who were able to control its work would see that due place was given to researches upon atmospheric electricity at high latitudes. "It is of more importance that a connected series of observations upon atmospheric electricity should be taken, than that such an expedition should penetrate a few miles nearer the pole."

CORRESPONDENCE.

Thawing by Electricity.

We are interested to note that Mr. Edmunds has reinvented our application of high resistance wire drawn into water pipes for the purpose of preventing freezing or thawing out the pipes when frozen.

Our experiments made with a freezing mixture gave results much the same as Mr. Edmunds describes, but, owing to press of business in other directions, we have not yet had time to make arrangements for the financing and pushing of the invention patented in January, 1893.

We think this in connection with a tube filled with air, which has been patented by Mr. G. Bidder, Q.C., would solve the problem most successfully, for should the pipe freeze, the air would be compressed and the pipe could not burst under any conditions.

With pipes protected in this way a householder could go to bed with an easy conscience, for if the pipes froze they could not burst, and if electricity were not obtainable on the spot to prevent freezing, the use of a few storage cells would thaw the pipes in a few minutes.

The chief difficulty will be the opposition of the plumbers to any invention which will destroy the golden harvest they are now reaping.

Drake & Gorham.

Ozone.

Will M. Andreoli, or any other authority on the subject, kindly reply to my following questions? It is said that carbonic monoxide, CO, is produced during the electrification of the air. Is the statement true? I know that by a "silent discharge" through air ozone, O_3, is produced, but I doubt whether this poisonous gas is also formed. What happens if a stream of CO_2 is treated with sparks or silent discharge? Will CO_2 be decomposed into CO + O, the latter gas being converted into O_3? Has thus treated CO_2 certain special properties or reactions?

Student.

Gas Engine Fly-wheels.

I shall be glad if you will give me a little information regarding the action of the heavy fly-wheel usually fixed upon the armature spindle of a dynamo when driven by a gas engine. Some people of whom I have inquired, say that the action of the fly-wheel is to keep the speed of the gas engine constant, and that it is therefore best to work with the belt as tight as possible and have no slip whatever; others say that the action is to make the speed of the dynamo independent to a slight extent of any variations in the speed of the gas engine by working with a slack belt and having some slip of the belt on the dynamo pulley, thus allowing the dynamo to keep up its speed, when the engine speed falls, before taking an explosion. Which of these is correct?

"Engineering Student."

[The latter is the more correct; even in the case of a small steam engine which was badly governed a fairly heavy armature fly-wheel would be useful.—Eds. Elec. Rev.]

The Niagara Dynamos.

In your last issue is a letter over the name of Prof. George Forbes relating to alternators with external revolving poles and fixed armature. Whilst I am unable to give any information on the real subject of the discussion as to the relative priority of Mr. Brown and Prof. Forbes in the use of this construction, I may contribute to the "historical" question by pointing out that the English patent, No. 14,562, dated July 28th, 1893 (or 20 days prior to Prof. Forbes' American date of application), granted to Mr. H. W. Ravenshaw and myself, is for an alternator with externally revolving poles, and the drawing accompanying the patent is taken from the drawings of such a dynamo made by Messrs. Easton, Anderson & Goolden, Limited.

Llewelyn B. Atkinson.

The Compiling of Catalogues.

Referring to your notice of a recent catalogue of electrical testing instruments, my attention has been called to a description therein of a galvanometer, designed and patented by me in 1891 to 1892, and named by permission "The Ayrton-Mather Galvanometer." I note that the illustration and description in that catalogue correspond to my list No. 2, of 1892 (No. 76), and would point out that the detail and arrangement of the instrument in question are covered by my patent No. 4,276 of that year. I regret that the firm issuing this list should copy the original designs of other makers.

Robt. W. Paul.

February 27th, 1895.

TRUTH AND FALSEHOOD AS TO ELECTRIC CURRENTS IN THE LIVING BODY.*

By VICTOR HORSLEY, F.R.S., F.R.C.S., &c.

My object in the following lecture is to put before you, so far as one may attempt to do in an hour, what is actually known concerning the existence of electrical currents in the living body that is occurring as phenomena of life. I shall then show you one or two rough experiments to illustrate the effect of electrical effects upon the body; and lastly, leave what is true, that is scientifically known of this subject, to draw your attention to the false ideas which largely prevail on the same, and which are made the foundation of so much fraudulent quackery.

In the first place we must understand what we mean by electrical current. What we actually mean is that there is apparently a transference of energy between two points which are in a different electrical condition, or to put it quantitatively, in which the electrical potential of one is greater than that of the other. It is for this reason that we speak of an electrical current as though it resembled a stream of water, which moved from some place where it has accumulated until it has a certain head or pressure, and in a like manner, seeing that water experiences a difficulty in flowing along a pipe or conductor by reason of friction against the sides of the pipe, so it is also the custom to speak of the electrical current as experiencing resistance when it is passing through a conductor. Although it is convenient, doubtless, to use the terms "current," "resistance," and so forth, in the same way as we do the analogous case of water, nevertheless this mode of speech is inaccurate, because there is no actual carriage or movement of the particles forwards in the case of electricity as in the case of a flowing current of water. What is occurring, is, of course, an active molecular state at any given point which finds resistance to intercommunication in the copper, or whatever metal it is introduced to.

Here also let me remind you that the commonest developments of the differences of electrical condition with which we are acquainted are the outcome of chemical changes; which chemical changes are also accompanied by changes in temperature, the fact being that all these physical states are but phases of energy. Just to give you an example of this, and one which will serve to be useful in explaining the construction of one of the instruments I shall refer to as employed by physiologists for the detection of currents, I will take the instance of the relation of motion and capillary attraction to electrical currents. Take a bubble of mercury immersed in a 20 per cent. solution of sulphuric acid, and two wires coming from an ordinary battery, the one passing into the mercury bubble, and the other into the sulphuric acid on the opposite side of the dish; you note that when I throw a weak electrical current into the preparation that the mercury moves in the line of the direction of the current. In other words, here we have a physical change of form occurring concomitantly with the transference of electrical force. Now, to show you how completely this is in accordance with the doctrine of the correlation of all forms of energy, we will detach the ends of the wires from the battery and connect them to a Thomson reflecting galvanometer, and then cause the mercury to move forward, the result being a concomitant development of electrical difference. The striking manner in which this simple apparatus works led Professor Lippmann to invent an instrument which is known as his electrometer, and in which the movement of the mercury through a fine capillary tube is magnified and measured by a microscope.

Let us now see what use we can make of the reflecting galvano-

* London Institution Lecture, February 11th, 1895.

meter so far as the living tissues are concerned. It is best, perhaps, for me to take as examples of animal tissue, either muscle or nerve, as being substances the anatomical, chemical, and physical conditions of which are fairly well known. Let us take a simple case first, namely, an uninjured spinal cord, and let us apply thereto a pair of non-polarisable electrodes connected with the galvanometer.

We shall then see that there is no electrical difference between one part of the uninjured cord or muscle and another, that in the majority of cases the result is absolutely negative. If, however, the cord, muscle, or nerve, is injured by cutting off one end, &c., then it is found that the injured part is negative to the uninjured; in other words, there is constant difference of potential between the two surfaces. This electrical difference between the two surfaces is commonly spoken of as the "resting difference," and is always present where a portion of living tissue is dead. If we connect the dead and living portion of the tissue with a galvanometer, we find that then the electrical state of affairs may be described as a current flowing from the outside of the tissue towards the centre of the injured surface, and from that through the mass of tissue to the uninjured surface, thus completing the circuit. The great discovery that animal tissues under these circumstances exhibit an electrical current (so-called "animal electricity") was made by Galvani more than a hundred years ago, namely, in 1786. Galvani discovered that if you took a muscle with its nerve attached and cut off one end of the muscle, and brought the free end of the nerve round so that it rested on the cut surface of the muscle that the muscle contracted, showing that its nerve had been stimulated by the "resting electrical difference." The same thing has been shown in an even more delicate way by taking the vagus nerve, excitation of which causes slowing of the heart, dividing it, and then lowering its cut end into the fluids which bathe the rest of its course, the result being slowing of the rate of the heart, inasmuch as the circuit between the two points is closed by the fluids in question, and the nerve consequently irritated. I now ask your attention to another change in the electrical condition of living tissues, a change which is of vastly more importance than the resting difference just described, because whereas I have just explained to you, the resting difference is only, after all, a death phenomenon, the one I am now about to touch upon is a truly vital effect. I have already drawn your attention to the fact that mere mechanical movement of fluids develops an electrical change, that is to say, the electrical change is a concomitant of the mechanical change of position.

When a nerve impulse travels along a nerve fibre it does so at a known rate, *i.e.*, about 40 miles an hour. But beyond this fact, and one or two minor points which I shall presently relate to you, we know nothing more about nervous energy, though, of course, we believe with Newton, that it is another form of "vibrations," and as such is analogous to electricity, magnetism, &c. Now, when nerve energy passes along a nerve fibre, or on its arrival in a muscle causes a wave of contraction to pass through that muscle, its passage and the contraction of the muscle are accompanied by a change in the electrical state of the tissue. Whether uninjured or not the tissue, whose physiological function is thus excited, reveals the presence of a very small current of an opposite direction to that of the resting difference. Because this weak current is associated with the functional activity of the tissue it has been termed by Prof. Herrmann the "action current," and is usually known by that name. It was termed, however, the "negative variation" by its discoverer Du Bois Reymond when first observed by him in 1840, because it was of course a variation in the resting difference or electrical condition of the nerve or muscle, and it was a variation in the opposite direction to the resting difference. Let me repeat, this action current is not the nerve impulse itself—a popular error concerning this subject is, that nerve impulses are electrical, whereas they are nothing of the sort; they are simply specific instances of the form of energy known as nerve force. The "action" electrical current is only a concomitant. In fact, to emphasise my point, I will allude to the successive fall of a row of bricks as set up by a child. Here we see a transference of movement from one end of the row to the other, and we hear the noise made by the falling bricks, so we know exactly what has occurred without necessarily seeing. In the case of the passage of the nerve impulse, or the physical changes inside the contracting muscle, we cannot see what is going on, we have no instrument that will reveal to our eyes the actual transference of nerve energy, but exactly as the noise of the falling bricks tells us what has occurred, so the action current informs us that a nerve impulse has passed. The analogy is strict enough, because we have a single nerve impulse accompanied by a single electrical change exactly in the same way as each brick in falling is characterised by a distinctive noise.

Now, although the action current is only a sign of what is occurring, nevertheless, because it happens with each nerve impulse, so it gives us precise information that the nerve impulse has passed, and that a vital phenomenon has taken place. As an indication, therefore, of active physiological function, this discovery of Du Bois Reymond is of the utmost value to us. It can be revealed with great ease by the capillary electrometer, the principle of which has already been explained. The mercury is observed passing along a fine capillary tube in exactly the same way as you saw the bubble move when an electrical difference is suddenly thrown into it. If instead of observing the movements of the mercury with the microscope, we focus with a strong light the shadow of the slender mercury column on a sensitive photographic plate, which moves behind the slit at a steady pace on one of Mr. Burch's water carriers, then if the mercury be perfectly steady we shall have a black shadow with a horizontal top recorded on the plate. If now we connect the electrometer with the nerve (cut end and uninjured surface respectively) we notice the mercury immediately assumes a lower position in the tube owing to the resting difference. (The value of the resting difference of the dorsal spinal cord in the monkey is ·022 Daniell.) It remains steady in this place, and then, if we stimulate the nerve by a single induction shock, we see that the mercury describes an upward movement, which lasts long enough to give with the relatively slow rate of the plate, an elevation with a rounded top, as shown in this photograph. If instead of the nerve, we connect the secondary coil of an induction apparatus with the electrometer, and photograph the movement of the mercury which results from a single induction shock, we get a record which is quite different in character, being in the first place sharp and apical, and in the second place it is not an elevation but a depression of the mercury, when the direction of the shock is reversed. This reversal of the shock itself is the crucial proof (apart from the difference in form) that the negative variation is a genuine physiological phenomenon, and not merely escape of current from the induction electrodes to the electrometer, because with the nerve or muscle, no matter whether the exciting shock is reversed or not, the movement of the mercury is always in the same direction when it is recording the action current.

I will now show you a further exemplification of the way in which this discovery of Du Bois Reymond can be turned to account in the observation of not only electrical changes in the central nervous system, but the determination, in part, of the intervals between the passages of nerve impulses. It had always appeared to me that if one could lead off the action currents which, theoretically, one must assume were developed in the spinal cord by the passage of each nerve impulse from the brain down through the cord and nerves to the muscles, it would be possible by recording such action currents to gain an estimate of the intermittence of the passage of such impulses. Some years ago I commenced experimentation upon this subject with Prof. Gotch, and the application of the method just mentioned exceeded our anticipations. We found that it was possible to estimate the character and amount of nerve disturbance; in other words, to form a rough guess at a rough quantitative value of the nerve impulses passing by, noting the nature of the electrometer movement and the degree of deflection of the galvanometer when applied to different tracks of the nervous system. The first object of our investigation was to photograph the action currents accompanying the descent of the nerve impulses down the cord, when the brain was stimulated. The photograph shows that during the excitation of the brain the nerve impulses are poured out with such rapidity that the action current, or currents, developed (for the rate at which the photographic plate was driven) show a continuous elevation of the mercury in the electrometer, but that after the excitation ceased, and when there follows an intermittent discharge of nerve impulses, so we have an intermittent series of leaps of the mercury. This is, therefore, an exemplification of the characteristic method in which the brain sends out its discharges in an epileptic convulsion.

To return, now, to the development of action currents in the body when physiological processes occur therein. It is easy to show that when our muscles are contracting that this vital phenomenon of electrical change occurs, since if we connect the galvanometer by suitable electrodes to the muscles of the arm, we see a deflection when we cause the muscles to contract, as in grasping an object. That this is merely an instance of a phenomenon which accompanies all functional activity of protoplasm, is shown by another example, namely, the development of an action current when the cells of the gland secrete; that is, when they separate from the blood by their own vital actions, certain chemical substances, which when combined and dissolved in water, also separated from the blood, constitute some specific secretion, as for instance, the secretion of saliva by the salivary glands, sweat from the sweat glands, &c., has been shown by several observers, notably by Bradford, that there is well marked action current, according to the circumstances of the secretion. A very beautiful demonstration of the "action current" is that produced during the heart beat, and first demonstrated in man by Waller.

I hope I have now made it sufficiently clear that the popular notion so frequently vaunted by quacks that electricity is life, is only one of the numerous impostures promulgated for the purpose of extracting money from the ignorant. There is no evidence other than that when the body is at rest, there is no electrical difference developed in any part of it; and so also there is no evidence that, even supposing exceedingly slight currents, such as I have shown you, to be developed by the passage of the fluids in the body along the vessels, that such currents are anything more than the physical concomitant of such movement, and serve no direct purpose in the economy of the body. Further, that when any part of the body is a seat of vital activity, again a slight electrical change is developed, and that this is to be regarded only as a concomitant, and that these insignificant electrical changes are not influenced in any way, at least favourably, by the passage of electrical currents from the outside.

Turning from what is absolutely known to describe the untruth of various notions concerning the effect of electrical currents on the body, I think that a few remarks must be here interpolated regarding the legitimate use of electricity as it is employed by medical practitioners in the diagnosis and treatment of disease. As regards diagnosis, electrical currents are used solely to stimulate nerve or muscle to find out whether they are in their natural excitable condition, and capable of reacting to known intensities of current. There is no mystery then attaching to this use of electricity.

The second point, namely, the use of electricity in treatment, is a subject in which so little is known with actual truth, that this has of course been seized upon by the quack as a favourable field for his operation. In *bonâ fide* practice, electrical currents are used in two ways. In the first place, simply as a mode of stimulating the functional activity of muscle or nerve when it appears probable that these are falling into abeyance from disuse due to disease; and secondly, electrical currents (usually the constant current) are sometimes used quite empirically and arbitrarily, in the hope that they will help to bring about chemical changes in the tissues, so that the nutrition of the matter may be beneficially affected thereby, and the natural chemical processes underlying growth and functional activity be encouraged. It must be clearly understood that this use of the

electrical current is purely arbitrary, and there is no scientific evidence whatever proving that there is any quantitative acceleration or increase of the tissue changes in the manner indicated. Unquestionably improvement occurs, but to what degree it is due to the electrical current, or in what way the latter may be supposed to act, are both points upon which no adequate research has yet given an answer. One fact, however, has been long known to the medical profession, and is pretty obvious to everyone who gives the matter a little rational consideration, and that is, unless the current employed is sufficient to counterbalance the resistance of the skin, no effect follows.

[Here Prof. Horsley indulged in some strong, but well-merited, tirades against the low commercial morality of the daily press for the wholesale fostering of quackery through the medium of mendacious advertisements, followed by some very flattering and eulogistic remarks anent ourselves and the *Pall Mall Gazette*, which, for obvious reasons, we omit.]

To review the position of the subject that we have been discussing it is now quite established that the development and production of electricity by living animal tissues which are not specialised as in the case of electrical organs in the electrical fish is extremely small, and is, in fact, only a very small accompaniment of the very important physiological functions with the exercise of which its appearance is associated. Further, it is also clear that the present employment of electricity, medically, is not known to do more than excite the tissues favourably, and that for this purpose, owing to the resistance of the skin currents to the passage of electrical currents, currents of a certain strength have to be employed, and such as cannot possibly be developed from the so-called belts or other appliances of the charlatan. It is pleasant, while speaking on a subject of this kind, to reflect with gratification that the spread of scientific knowledge which is going on at the present time, and which we all hope to see increased, will be the certain means of ultimately extinguishing such popular fallacies and unfortunate instances of credulity as have been lately before the public.

LEGAL.

The Cassel Gold Extracting Company *v.* The Cyanide Gold Recovery Syndicate.

Sir Richard Webster, Q.C., on behalf of the Cassel Gold Extracting Company, Limited, replied on the whole case on Friday before Lord Halsbury and Lords Justices Lindley and Smith. He said the case was one of very great importance and of extreme difficulty, and from first to last, both in the Court below and before their Lordships, he had not attempted to present it in any other light than one involving very difficult questions. Throughout the whole consideration of the case in the Court below, Mr. Justice Romer seemed to have been impressed with the view that there was nothing for his decision except the subject-matter of the MacArthur patent as affected by the state of public knowledge before the date of his specification. The first and most important matter referred to again and again at every stage of the argument of his learned friends was, in the Court below he (Sir Richard) either did abandon, or led them to believe that he abandoned the claim for selective action. This point he intended first to consider in his reply. The second point was what was the proper construction of the plaintiff's specifications? and here, again, some little difference occurred between him and his learned friends, who stated that in the Court below he put a construction on them different from that which was now presented before their Lordships. The third question with which he would deal, was that of "disconformity" between the provisional and complete specifications, but assuming that he could satisfy their Lordships that he was right with regard to selective action, then the point of disconformity would not arise. The fourth point was want of novelty, and that would depend on the construction of the specifications and the subject-matter of the patent. He would also deal with Rae and Simpson's patents. With regard to the first point (selective action), if there had been any misunderstanding about his position on behalf of the Cassel Company, it was perhaps his own fault, still, he averred that looking through the whole of the proceedings from beginning to end, there was no trace of any statement by counsel which could have misled them, and from start to finish there was nothing in the evidence which could induce the belief that selective action had been given up. It was first of all necessary to understand clearly what it was that he meant by selective action. What he meant all through this case was that a dilute solution of cyanide of potassium within certain proportions did, in fact, have this selective action on ore, that it did extract the gold and silver and leave the other metals behind. He had never suggested that there was no solution of the other metals—that the iron and copper, &c., were untouched—but that if the solution were of greater strength the baser metals would also be brought in solution and then there would be great difficulty in extracting the gold from the solution. There never was a question of "order," but a question of how to treat large quantities of ore by the ton to the best commercial advantage. A weak solution of cyanide of potassium had a selective action to this extent, that it dissolved the gold and silver and left behind the bulk of the iron and copper and whatever metallic substances there were in the ore.

Lord Halsbury said he certainly never understood that Sir Richard had abandoned, or intended to abandon "selective" action.

Sir Richard Webster said that during the trial in the Court below there was a sort of depressing atmosphere surrounding counsel for the plaintiff company, because Mr. Justice Romer from the very opening seemed to take the view that there was no subject matter for a patent. He said again and again that the plaintiff's patent was only for applying a process for dissolving gold by cyanide of potassium, a process perfectly well known, and taking that view he seemed to think that the plaintiff's claim was beside the mark. Referring to the provisional and complete specifications Sir Richard was unaware that he had ever said that the plaintiff's claim was for any particular strength of cyanogen. The provisional specification was a general claim, and the complete specification, was for a solution proportioned to the amount of gold and silver contained in the ore to be treated. In the first claim the solution was substantially described; and, in the second, stated, in effect, that the cyanide in solution must be proportioned to the gold in the ore, not with regard to the strength, but with regard to quantity. If the ore was richer than supposed, then the strength of the solution would not be increased, but its bulk—the strength being the same.

Lord Halsbury: Otherwise its action would be destroyed.

Sir Richard Webster agreed, the strong solution would attack the baser metals, and so render it difficult to get the pure gold out of the solution. Profs. Dewar, Roberts-Austen, and Crookes, and Mr. MacArthur, all gave evidence on this point. With regard to Rae and Simpson's patents there was no indication to enable the experimenter to say where he was to begin to extract the double cyanide of gold from the solution. Both Rae and Simpson's processes failed because there was a failure to bring the cyanide in contact with the zinc, and one great merit of Mr. MacArthur's invention was that he discovered how to recover the gold in solution in its metallic form. In conclusion the learned counsel submitted that on all grounds the plaintiffs were entitled to succeed on the appeal.

Their Lordships took time to consider their judgment.

National Telephone Company *v.* Shand.

At the Greenwich County Court last week, before Judge Bristowe, Q.C., this action was heard. The defendant was formerly general manager of the Victoria Steamboat Association, and the plaintiffs sought to make him liable for the sum of £12, one year's rent of the telephone to his private house at Breakspear Road, Brockley. The judge was satisfied that the bargain was with the association, and gave judgment for the defendant, with costs.

BUSINESS NOTICES, &c.

Now Ready.—The Universal Electrical Directory. This directory, which is now on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Arlesley.—The Lighting Committee recently considered the lighting question and decided in favour of gas works being erected. They have now been requested to make further enquiries, especially regarding electricity and oil lighting.

Brentwood.—A petition is being signed here protesting against the bad gas lighting, and requesting the lighting inspectors to consider the question of lighting the parish roads by electricity, with overhead wires at a cost of £150 per annum. At present £260 is spent on gas. The signers of the petition consider a 2d. rate would meet the cost.

Brighton.—Brighton Grand Hotel Company, in August, took supply of current from the Corporation instead of from their private plant as formerly. So far they have effected a total saving of £505. The private plant is consequently to be disposed of.

The Council have agreed to the recommendation of the Lighting Committee, and have accordingly decided to purchase the two houses to which we referred last week.

Bristol.—Through the courtesy of Mr. Faraday Proctor, the Borough Electrical Engineer, the Engineering Society of the University College, visited the Bristol central station on February 20th.

A deputation from Kingswood are to visit the Bristol central station to obtain information *re* testing the electric light.

It has been decided to light both the choir and nave of Bristol Cathedral by electricity.

Ealing.—The Urban District Council find it imperative that, for financial reasons, they must promptly take some definite steps to raise, either by issue of stock, or otherwise, £25,000, which is the sum authorised to be borrowed for electric lighting purposes. The Local Government Board recently decided not to grant their sanction to such an issue by the Local Board, the latter body thereupon begged them to reconsider their decision. To this request no reply has yet been received, and they are to be again communicated with by the clerk.

Edinburgh.—The Gas Committee and the Electric Lighting Committee are to meet together to discuss the question of main box explosions, and to decide the best means to be adopted to prevent their occurrence.

Huddersfield.—For the year ended December 31st, the electric lighting accounts show a deficit on revenue account of £2,065 4s. 9d. An important feature in the accounts is that the money originally expended has to be repaid in fifteen years, this necessitating a large sum being placed each year to sinking fund. This is responsible for a certain portion of the deficit.

Kingston.—A Local Government Board inquiry was held at Kingston-on-Thames on Monday into an application by the Corporation for sanction to borrow £10,000 for the purposes of electric lighting.

Liverpool.—The Special Lighting Committee had an interview with the directors of the Liverpool Electric Supply Company, this being the most advanced step yet taken in connection with the negotiations for the purchase of the undertaking of the company.

Manchester.—Messrs. Bennett & Druce have received instructions to proceed with the electric lighting of the three-storied sheds at the Manchester Ship Canal Company's Salford Docks, where about 500 lights of 32 and 50 C.P. will be required.

Portsmouth.—The Electric Lighting Committee recommend the Council to revise the salaries of all employed at the electric light station. They propose that the salary of Mr. Price, the superintendent, shall be increased to £250.

Preston.—Messrs. Bennett & Druce have just completed an electric light plant for the St. Joseph's Church and Canon Walmsley's house, Preston. The installation consists of about 150 lights, complete with gas engine, shunt wound dynamo, and accumulators. In this installation the light is taken from the accumulators solely, the engine and dynamo being used simply for charging these latter. The lighting of the new "Farmer's Arms" Hotel, Preston, has also been entrusted to Messrs. Bennett & Druce. About 150 lights will be installed, the current being taken from the Supply Company's mains.

Reading.—The Reading Electric Supply Company have issued a notice stating that they will shortly be able to supply current in stated thoroughfares, the price per unit to be 8d., subject to 50 per cent. for large users.

Sheffield.—On 18th inst. the students of the mechanical and electrical engineering classes at the Central Schools, Leopold Street, visited the central station of the Sheffield Electric Light and Power Company.

Shrewsbury.—The Shropshire Electric Light and Power Company are now pushing on with the work of laying mains in the district.

Southend.—To use the expression of a local councillor the lighting of the borough is a "standing disgrace," and a committee has been appointed to consider the position of the council in regard to their electric lighting powers.

Warminster.—The Chairman of the District Council, the other day, moved that application be made for an electric lighting licence, but not knowing at the time that the licence would cost anything, he, later on, withdrew his motion, and the matter is postponed indefinitely. Doubtless private enterprise will have to step in before the Council will move in the matter.

Whitehaven.—Some of the *employés* at the central station work 12 hours a day, for seven days a week, for five months at a stretch. At the last meeting of the Town Council the matter was lengthily discussed, members protesting most strongly against such conditions of labour. In consequence, we believe, the matter is to be looked into.

The electric lighting repairs necessary under the contract with Messrs. Siemens Bros. & Company, Limited, are to be, at the firm's request, carried out by the Council and charged to them.

A report was recently prepared on the cost of fitting the Town Hall with electric light. A councillor moved the postponement of consideration until August, 1895.

Worcester.—The Theatre Royal auditorium is to be lighted by electricity, the total number of lamps being 70. The directors have given out the contract.

Yarmouth.—Orders have been received for 2,468 lamps, of which 1,181 are connected and current is being supplied. Plant laid is equal to 4,500 8-C.P. lamps. Mains are to be laid in Jetty Road.

Yeadon.—An expert electrician is to be called in to examine and report upon the electric lighting tenders which have been sent in.

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court, held before Mr. Registrar Hope on the 21st ult., Wm. David Gooch, electrical engineer, formerly of Victoria Mansions, Westminster, applied for an order of discharge. Mr. H. Brougham, Official Receiver, reported that the accounts showed ranking liabilities £4,365; proofs had been tendered to the amount of £2,147; and there were no available assets. The bankrupt carried on business on his own account from 1885 to 1888, during which time he incurred the bulk of the indebtedness in connection with speculative electrical contracts, &c. As offences the Official Receiver reported:—(1.) Assets not equal to 10s. in the £ on the unsecured debts. (2.) Trading with knowledge of insolvency; and (3), contracting debts provable in bankruptcy without having reasonable expectation of being able to pay them. Mr. Bartley Dennies appeared for the bankrupt in support of the application and offered to have judgment for £150 entered against the bankrupt as a condition attaching to the discharge. After hearing the case the learned Registrar said such an offer could not be entertained, as it was simply sactioning a scheme for the payment of less than 7s. 6d. in the £. He regarded the offence of insufficient assets in a rather serious light, seeing that the debts amounted to £4,300, and there were no assets at all. It had been urged that £1,000 of those liabilities were put upon the bankrupt in connection with the Oldham Exhibition under circumstances of a misleading nature to the bankrupt. Allowing for the deduction of that sum there was still a deficiency of over £3,000. It was clear that the bankrupt had undertaken electrical lighting contracts—which must always be considered as more or less speculative—without having sufficient funds at his command to carry them through with success. Having regard to all the circumstances of the case the order of discharge would have to be suspended for three years. Mr. Bartley Dennies intimated that his client would propably apply for a re-hearing of the application.

The first meeting of the creditors of Walter Andreae, electrical engineer, lately carrying on business at 47a, Lower Belgrave Street, as Walter Andreae & Co., was held on February 22nd at the London Bankruptcy Court. Mr. G. Wreford, Official Receiver, who presided, stated that accounts had been lodged showing gross liabilities £2,361 2s. 1d., of which £2,035 2s. 5d. is expected to rank, against assets valued at £145 10s. 8d. The debtor was in attendance, and said he had no offer to submit. No resolution was passed and the case was left in the hands of the Official Receiver to be wound up in bankruptcy. The public examination is appointed for March 6th.

Catalogues, &c.—We have before us two catalogues dealing with American electric traction manufactures as supplied by the Peckham Motor Truck and Wheel Company, of New York, Chicago, and Boston, for whom we believe Mr. Robert W. Blackwell, of 39, Victoria Street, S.W., is representative in this country. The first of the two books contains information, chiefly in the nature of illustrations, of the Peckham Cantilever extension truck frames, side frames, the "Excelsior" extension truck, the "Standard" cable truck, the "Extra Long" cable truck, "Swivel" truck, Evan's open car truss, interchangeable "cushioned" motor wheels, motor collars, lever brakes, and a quantity of electric traction accessories. There are a large number of good full page illustrations of trucks and cars, and others showing the various departments at the company's truck works. The second book describes the system of the Metropolitan Street Railway Company, and gives photographs and notices of the principal officials of the company. It is stated in this book that most of the cars of this railway company are mounted on cantilever extension trucks manufactured by the Peckham Company. Both of these books are most excellent publications, prepared with much elaborateness, and without grudging of either money or labour. They are books which should be of the greatest possible use and interest to those connected with the electric traction industry, especially in these days, when electric traction is, despite the London County Council, making such progress.

From Messrs. A. and J. M. Anderson, of 39, Victoria Street, Westminster, who are contractors for electric tramway supplies, we have received one of their 1895 calendars. The most attractive feature in this calendar is an excellent steel engraving, the subject being "In the High Mountains of Norway."

Electric Organ.—During the past year a magnificent Hope-Jones electric organ, costing £1,500, has been erected at Gilfillan Memorial Church.

Exhibition at Sheffield.—At the Drill Hall Exhibition recently held here, Mr. T. Scott Anderson made some interesting demonstrations in electric welding, hardening, and tempering.

Halifax and Bermudas Cable Company.—An official notice has been given in the Private Bill Office of the House of Lords, that this company do not intend to proceed any further with their deposited Bill, to which we have already referred, for this session.

Lockwood's Builders' and Contractors' Price Book.—The new edition for 1895 contains, in addition to the usual prices and memoranda, which have been revised and corrected to date, an electric lighting section, giving the latest information relating to "this most important branch of the building trade." The full text of the new London Building Act, 1894, with annotations and explanations, is given in a supplement, together with other valuable matter of a legal and general nature.

Nalder's Self-Induction Measuring Instruments.—Profs. Ayrton and Perry's secohmmeter, which we illustrate, consists of two rotary commutators each with four stationary brushes. The commutators are on the same spindle, one at the front and the other at the back of the secohmmeter (one seen in the figure). One commutator is for periodically reversing the galvanometer connections, and the other for reversing the battery connections. An adjustment is provided for enabling the relative positions of the two sets of brushes to be varied so that both sets of reversals can be made to occur simultaneously, or one a little before or after the other, or one reversal midway between two successive reversals of the other. The commutators can be driven at one or other of two speeds relatively to that of the driving handle. With one arrangement there are four reversals of both the galvanometer and of the battery for one revolution of the handle, and with the other 24 reversals of each for one revolution of the handle. The secohmmeter can be conveniently driven by hand so as to obtain a constant speed of reversal varying from 200 to 6,000 reversals per minute of both the galvanometer and the battery. The present design of instrument is a great advance on the previous form. The connections are all outside and visible, and

the brush-holders are easily set with respect to each other. A mere fraction of the power that was previously necessary is now required to turn it. The whole instrument is now made in metal and ebonite with a bevelled glass top and is in every way superior to the old pattern. There are two shafts on either of which the handle fits, for high or low speed ratios. The principle of the instrument may be briefly explained as follows: If a coil having self-induction be joined up in the usual way to a Wheatstone bridge and balance obtained when the battery key is first depressed and then the galvanometer key, it will be found that on reversing the operations, *i.e.*, first depressing the galvanometer and then the battery key, that there will be a sudden impulse on the galvanometer in one direction on completing the battery circuit, and an equal impulse in the opposite direction on breaking that circuit, which impulses are a measure of the self-induction of the coil. If instead of making and breaking,

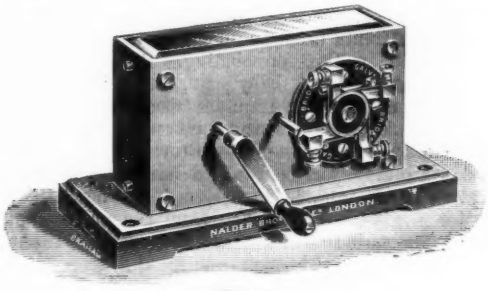


Fig. 1.

the battery is reversed, the same effect is produced but the impulses are double the former ones. The secohmmeter is designed with one commutator to reverse the battery circuit periodically when rotating, so that a succession of these impulses would be given to the galvanometer. As these impulses, however, are alternately in opposite directions no permanent deflection would be obtained on the galvanometer unless its terminals were periodically reversed between successive reversals of the battery. The second commutator is provided for this purpose, and being on the same shaft always reverses the galvanometer between reversals of the battery, so that a succession of throws in the same direction are obtained which results in a steady deflection depending on the self-induction of the coil and the number of impulses per second, or speed. The instrument is, however, most conveniently used with a zero method. If in the two adjacent arms of a Wheatstone bridge there are two exactly similar coils as regards self-induction and resistance, then to produce balance with steady currents resistance of the other two arms would be equal. It is obvious that if their self-inductions were also equal no deflection would be produced on rotating the secohmmeter. With unequal ratios the self-inductions are proportional to the resistances. A drop of clean dry *paraffin* oil should be occasionally put on each of the commutators where they are rubbed by the brushes, and the other moving parts of the instrument should be kept well lubricated, preferably with paraffin oil.

Profs. Ayrton and Perry's variable self-induction standard consists as shown in fig. 2 of two coils connected in series. The smaller coil revolves inside the other so that it may be inclined at any angle with it, and by this means the self-induction may be varied continuously between a minimum and a maximum value. The arrangement is a modification of that used by Professor Hughes (and suggested as a variable standard of self-induction by Lord Rayleigh). The coils, however, are much wider axially and shallower radially, and in shape

Fig. 2.

are parts of concentric spheres, so that the inner coil may be very close to the outer, and yet be free to revolve inside it. By this means a large range of values has been secured. Two scales are provided, one reading directly in quadrants or Secohms, and the other being a proportional scale which is merely used by us in the calibration of the instrument. The wire is of copper, so that the resistance may be as low as possible for a given value of the self-induction. The range of the instrument as made is usually from about ·004 to ·040 Secohms or Henrys. In order to increase the range of the variable standard it is convenient to use coils of known self-induction in series. For this purpose single coils can be used which are made to any value from 10 to 1,000 millihenrys. In order to still further increase the facility of working, a box of four coils has been designed, as illustrated in fig. 3, in which any coil can be used, or any or all in series, by un-

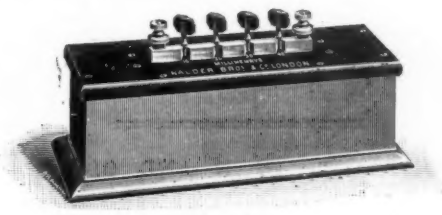


Fig. 3.

plugging as in an ordinary resistance box. The coils being carefully arranged so as not to interfere with one another, the self-induction is simply the sum of that of the coils unplugged. The usual form has coils of 10, 20, 30, and 40 millihenrys, so that the range is from 10 to 100 millihenrys. Boxes of larger range can also be made.

Manchester.—The Manchester Head Post Office is about to receive its electric lighting equipment, and the various works have been put in hand. There are to be 42 arc lamps of the Brockie-Pell type, so extensively used by the Postal Telegraph Department, and 704 glow lamps, mostly of 16 C.P. The generating plant will consist of three marine type boilers by Messrs. Tinkers, Limited, of Hyde, near Manchester, who also supply the steam pipes, pumps, tanks, &c.; and three 50-kilowatt Willans-Holmes combination steam dynamos, to be supplied by Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne. The installation of switchboards, lamps, and fittings, has been entrusted to Messrs. Laing, Wharton & Down, of New Bond Street, W. The whole of the works will be done under the supervision of Mr. W. H. Preece, C.B., engineer-in-chief to the Postal Telegraph Department, and he has selected Mr. A. F. Guy, late of the electric lighting staff at the General Post Office, London, to be his Clerk of Works. It is anticipated that the plant will be running about midsummer.

Some Country Lighting Installations.—Mr. F. Shalders, of Southampton, has secured the contract for lighting the new Isle of Wight County Asylum, the plant consisting of engine and dynamo for the heavy load, an engine and dynamo for charging battery and emergency, switchboards, steam pipes and wiring for about 800 lights. He is at present also putting down an installation at Fen Place, the residence of J. Stewart Oxley, Esq.. The plant comprises engine and dynamo, accumulators, motors for pumping, churning and cream separating, switchboards and wiring for about 200 lights. Mr. Shalders is also wiring throughout the new county offices, Winchester, for about 120 lights, and he has just laid down a complete organ-blowing plant for the Church of St. Lawrence, of Southampton, the power for driving motor being obtained from the local supply companies mains. The supply and regulation of wind is perfect in every respect, and gives extreme satisfaction. This plant was designed and laid down by Mr. T. Davis, who also superintends the installations previously mentioned.

Water-Power.—At a meeting of the Inverness District Committee last Friday, application was made on behalf of the newly formed British Aluminium Company for authority to divert certain roads in the neighbourhood of Foyers, so as to allow of Lochs Forraline, Garth, &c., to be raised from 10 to 20 feet to provide water for turbines for the production of electricity.

Williamson & Joseph.—This firm have just published a new catalogue, neatly and tastefully bound in red cloth covers, with gilt lettering. It is dated March 1st, so that all the prices which are set down may be considered the latest. Generally speaking, the book deals with electric light fittings and accessories. Porcelain electrical goods—of which, by-the-way, we understand Messrs. Williamson and Joseph were the first manufacturers over here, are a prominent feature. The prices of articles made of this material are lower, and the quality is much better, than was formerly the case. This firm have always made a special point of turning out only high-class work, but in the present catalogue they have been enabled to materially reduce the prices, while the quality of the work will not be allowed to suffer on that account. The prefatory note is followed by a very accurate and complete index, which has been prepared by Mr. Joseph himself, by whom also, we might mention, the whole catalogue has been carefully compiled, the work necessitating the expenditure of a great deal of time and money, and the exercise of great discretion. Switchboards and switches of various patterns and sizes are first dealt with, and are illustrated, as is nearly every article in the catalogue, by very neat blocks. We observe main switchboards for use in engine rooms, collieries, and with accumulators, also distributing switchboards, of the lever and laminated patterns, and others for small currents. A variety of testing and measuring instruments follow, also cut-outs and branch switches. An automatic cut-in and cut-out for use in charging accumulators, and capable of being adjusted to any current or voltage within the limits of range, is worthy of mention. The firm's new patent system of electric light regulation (double filament lamps) we described in these columns a few weeks back. Ceiling roses, wall sockets, lamp-holders, and incandescent lamps, are among a flood of accessorial articles. In the matter of incandescent lamps, we understand that

the firm during the year 1894 supplied over 8,000; of these, not one being returned as defective. Wires and cables are dealt with in the usual tabulated form, and projectors, gas engines, small motors, boilers, steam engines, brass and copper electric light fittings (some of the patterns shown being very fanciful and artistic), silk shades and glass globes are allotted suitable space. In regard to pendants, Messrs. Williamson & Joseph are supplying these all complete, and have given prices accordingly, so that customers may be saved the trouble of ordering lamps, lamp-holders, shades, roses, &c., from separate manufacturers. The last six pages contain well-arranged price lists of glassware, fittings, standards, and brackets. Mr. Joseph and the firm are to be congratulated upon a very creditable piece of catalogue compilation, which should be very beneficial to their customers.

CONTRACTS OPEN AND CLOSED.

OPEN.

France.—March 7th. The General Direction of the French Posts and Telegraphs in Paris, are inviting tenders for the supply and delivery of about 442 kilometres of telephone cable of different kinds.

France.—March 9th. The Prefecture of the Seine, in Paris, is inviting tenders for the contract for an installation of electric lighting in the St. Louis Hospital.

France.—March 10th. Tenders are being invited by the municipal authorities of Lesparre, a small town near the mouth of the river Gironde for the concession for the electric lighting of the town.

Spain.—March 9th. The municipal authorities of Cullera, a small seaport town in the province of Valencia, are inviting tenders for the concession for the electric lighting of the public streets during a period of 20 years.

Spain.—March 18th. The Spanish Minister of Public Works is inviting tenders for the concession for the establishment and operation of a telephone exchange in the old town of Salamanca, in the province of Leon.

CLOSED.

Darenth.—The Metropolitan Asylums Board have accepted the tender of Messrs. F. C. & P. M. Benest to supply and fix overhead electrical fire alarm wires and posts between the Darenth Schools, the farm buildings and the Gore Farm Hospital for £72; and maintain the complete electric bell system for three years for £75 per annum.

Norwich.—At the meeting of the Town Council, on Tuesday, the tender of Messrs. Laurence & Scott, at £458, to erect fittings for the lighting of St. Andrew's Hall was accepted.

Yarmouth.—Messrs. Crompton & Co., Limited, are to supply carbons for one year at £8 17s. per 1,000 pairs.

NOTES.

Electric Light Matters at Cardiff.—Electric light matters here are having a very rough time of it. There appears to be a certain clique of captious critics at Cardiff who are doing all they can, in writing and otherwise, to kill electric lighting. Within the past six months there have been most childish displays of petty personal feeling, and some of the statements which have been published in the local Press have savoured very much of what is far from accuracy and truth. While some of the correspondents have pretended to write their views solely for the purpose of assisting the authorities at the station, there is little doubt that the absurd confabs that have taken place have done more harm than good. Almost everything that could be devised to hinder the progress of electric lighting has been tried. We are therefore glad to see occasionally a letter from the other side, and as an instance we may refer to that of a local electrical engineer who has for some years had charge of central station machinery, and has visited several large central stations both in England and the United States. He considers the Cardiff station machinery to be working second to none he has seen. Of course, we ourselves do not attempt any comparison of Cardiff with other stations, but we mention this local opinion—which is one of many of its kind—to show that there is little unanimity in the wholesale condemnation that has been heaped upon Mr. Massey's installation. Few large stations run their first year without any hitches, and Cardiff has had small failures in its supply, but not more than some other places.

The Institution of Junior Engineers.—At a meeting of this Institution recently held at the Westminster Palace Hotel, Victoria Street, the chairman, Mr. Henry J. Young, presiding, a paper was read by Mr. Walter J. Fryer, A.I.E.E., on "The Practical Application of Alternating Current Motors." The difficulties of running alternate motors from lighting circuits, especially in England, where single-phase currents at high frequency are used, were first indicated, and it was proved that they could be successfully overcome. Describing the several classes of these motors, the author showed that a single-phase motor was one which was energised by simple alternating currents; a two-phase motor, one actuated by two currents differing in phase, and traversing the field in two distinct courses. In a three-phase motor the angular effect of the currents usually differed by either 120° or 60°, according to the method of winding. Rotary field multiphase motors consisted of many poles, the windings of which were so arranged, that the resultant magnetic force passed successively through each, causing the poles to travel in a rotary manner. A single-phase Brown motor, with the method of winding, was then fully described, as was also its application to an installation designed by the author, the supply for which had been taken from the public lighting circuits. The various arrangements for rendering the motor self-starting on load, and for preventing the sudden rush of current, which would cause the pressure at the lamp terminals to drop, were illustrated by numerous diagrams. Electromotors possessed great advantages, and there appeared to be no doubt but that they would eventually very largely supersede all other forms of motive power machines, on account of economy, compactness, and ease of regulation. Examples of large installations in Switzerland were cited, and photographs of them exhibited to the meeting. In one instance as much as 900 H.P. was transmitted a distance of nearly 10 miles, and used exclusively for motor work. This plant was on the three-phase system, the current from the generators being transformed up to 13,000 volts at the station, transmitted by aerial conductors, and transformed down to 190 volts at the works. Three-phase motors had several important characteristics in their favour; it was impossible to overheat them; they could be overloaded without fear of a burn out, and being without commutators, they required the minimum of attention. Several motors were on view which had been lent by the General Electric Company and by Mr. H. F. Joel. An animated discussion followed the reading of the paper, in which Messrs. P. G. Bowen, A. W. Marshall, A. S. D. Arundel, H. F. Joel, A. H. Dykes, W. B. Clarke, C. J. Mittelhausen, A. H. Stanley, R. Marshall, H. B. Vorley and the Chairman took part.

A Submarine Volcano.—The French Geographical Society has received from General Venukoff a communication describing a submarine volcano which is under survey by the officers of the Russian despatch vessel *Lotzman*. The volcano declared itself last summer, and, although under sea water level in the Caspian, projected a large quantity of mud and *debris* into the air. As a result of the survey, the position of the volcano has been determined as 38° 13′ 30″ north latitude, and 52° 37′ east longitude from Greenwich meridian, and above 24 miles from shore. The diameter of its crater is less than 20 feet, and at 200 fathoms from its centre the depth of water is about 8 fathoms, while at a distance of one mile the sea has its normal depth. We draw attention to the foregoing as a matter of interest to engineers and others connected with submarine cable property.

Institution of Electrical Engineers.—At a students' meeting to be held in the Institution Library, on Friday next, March 8th, at 8 p.m., Mr. Leonard Johnson will read a paper on "Incandescent Lamp Manufacture."

Appointments.—Mr. John Ernest Chester, late of Leicester, has been appointed Electrical Engineer and Practical Demonstrator to the Central Higher Grade School, Sheffield.

Mr. M. G. Ross having resigned his position as managing engineer to the Hastings and St. Leonrd's-on-Sea Electric Light Company, Mr. Leonard Andrews (who has had the charge of running the station for the past 16 months) has been appointed to take over his duties.

The Telephone Agitation.—At a meeting of Scotch members held at the House of Commons on Wednesday, under the presidency of Sir Charles Cameron, it was decided to support Mr. Benn's motion for a Select Committee to consider the proposed agreement between the Post Office and the Telephone Companies, and to report on the whole question of the telephone service.

Errata.—In our abstract of Mr. Riccardo Arno's on the "Retardation of Polarisation in Dielectrics," which appeared in our last issue on page 243, the concluding paragraph refers in error to a table which we were unable to publish.

In our article last week on the "Selection of Motive Power," a slight error occurred in the figures. In the first column, ninth line from the bottom, for "14,500 units" read "10,100 units more," and for "10,100 units" read "5,700 units."

Fatal Accident at Bristol.—We regret to learn that a most deplorable accident occurred at one of the sub-stations of the Bristol Corporation Electric Light Works on Monday afternoon, February 25th, resulting in the death of a linesman. The deceased, Robert Coleman, had been engaged by the Corporation as a linesman for twelve months, prior to which he had been employed by Messrs. Siemens Bros., National Telephone Company, &c., and was a thoroughly sound and good man in every respect. Coleman has been entrusted with the keeping in order of the sub-stations for some months past, and at the time of the accident was wiping down the high tension board with a cloth, and was wearing an india-rubber glove on his right hand for the purpose. Whilst so working he looked away to speak to another person present, and his left hand accidentally came in contact with a fuse terminal, he thus making contact to earth with the 2,000-volt mains. Every effort to restore him was without avail. A medical man was on the scene within two minutes. On Wednesday afternoon an inquest was held by Mr. Barker, Deputy Coroner.

Mr. Faraday Proctor, engineer to the civic electrical department, explained how the accident occurred. In the part of the cellar furthest from the street, is fixed horizontally the high tension electrical fuse board. The current sent out from the central station, near St. Philip's Bridge, at a pressure of 2,000 volts, here passed over a fuse board, the fuses being removable from their sockets by porcelain handles. The deceased had to wipe down the apparatus, including the fuse board, and since October 11th last he (deceased) had frequently done this work. There were no printed rules as to the method of working, but the imprinted rule was that the men should work with one hand only on any high tension work, and should wear an India-rubber glove on that hand. Such gloves were supplied at the central station, and they insulated the hand and conferred immunity from accident. It was necessary that this apparatus should be cleaned while the electric current was passing, and it would not be possible to cut off the force from the central station when these high tension machines were being cleaned. There were 15 of these sub-stations in Bristol and Clifton, and the apparatus in these was wiped over every week. It would be a most serious interruption of the supply to stop the current.

The Coroner: As a matter of experience it would be impossible to cut off the supply of electricity at either of these sub-stations before cleaning the high tension apparatus?—Yes.

Witness, continuing his evidence, said the deceased must have known the current was passing, or he would not have worn a glove.

By Mr. E. J. Taylor: The deceased knew his duties. The object of wiping down the apparatus was to remove dust, which, especially when damp, caused leakage of current. No polishing was necessary. The regulations with regard to this work had been communicated to the deceased. Had he followed the regulations no accident would have been possible.

William J. R. Wilcocks, Troy House, Arley Hill, an improver at the electric light works, said he was with the deceased on Monday afternoon, but was merely looking on to learn. After the accident he pulled the man back and tried artificial respiration, and then went for Dr. Page. Deceased, who had become unconscious on receiving the shock, died while witness had gone for some water.

By Mr. Taylor: They had been to two sub-stations before that, and at both the deceased cleaned the terminal in the same way—using both hands. Witness had not heard it was not necessary to clean the slot.

Other witnesses were examined, and a verdict of accidental death. Suggestions were made that a baluster brush should be used for dusting; that two gloves should be worn, and that printed rules should be circulated amongst workmen.

Obituary.—Our readers have doubtless heard through the daily press of the decease of Lord Aberdare, which we regret having to record. The deceased peer will be remembered as one of the first directors to head the Woodhouse & Rawson United prospectus.

Electrical Drilling Machines.—In response to some comments made in the *Engineer*, Mr. F. J. Rowan, of Glasgow, writes to that journal giving some further details of his patent electrical drilling machines, which were used in the construction of H.M.S. *Talbot*, at Devonport Dockyard. These drillers are fitted with electro-magnets for holding on the machine in its work, and it is stated that similar machines have been successfully used in the construction of H.M.S. *Endymion*, *Royal Sovereign*, *Gibraltar*, and others, also the Japanese *Matsushima*, and several other foreign war vessels, without the production of any magnetic effect as was hinted by our contemporary. "In addition to these facts," says Mr. Rowan, "the effect foreshadowed in the paragraph—whether we understand the writer to mean that the entire hull is made into a huge magnet, which would of course interfere with the magnets of all the compasses, or that some residual magnetism is left in the plates of the hull, or rather in portions of the plates, which might affect an individual compass needle if placed in the vicinity of that magnetised portion—is entirely illusory, and could not possibly be produced by the action of any such machine. The area embraced by the holding magnets is only a fractional part of the surface of any one plate, and in the course of drilling a number of holes, the magnet poles are so often reversed in position relatively to one another, that any magnetic effect produced in a plate or part of a plate whilst a hole is being drilled is effectually dissipated and destroyed long before the work on that plate is completed. Moreover, it is extremely difficult to magnetise permanently by contact, anything but the hardest of steel, and neither ships of war nor any other ships are built of such material. It may be suitable for razors or surgical instruments, but is decidedly not suitable for ships' plates and bars. Unless your paragraph was 'wrote sarkastik,' I think it is possible that another smile might be caused by the magnetic candle scare in a new form." Replying to Mr. Rowan, the *Engineer* says that gentleman is perfectly right, especially in his concluding conjecture. The summing-up of the whole business is that the Admiralty having objected to the magnetic candles in one case, and approved of the electro-magnetic drills in the other, stultify themselves, as it is obvious that if they were right in the one case they were wrong in the other.

Main Box Explosions.—We have this week to record several more explosions in main boxes. On Saturday night, in Gee Street, in the Euston Road district, a main box cover was blown into the air along with a portion of the pavement. There was, as usual, a loud report. Almost simultaneously, further down the road, another similar explosion occurred.

Huddersfield is also following the fashion, for on Friday morning last there was an explosion of the same nature in Market Street, in front of the Queen's Hotel. The same night two further explosions occurred at another part of the city.

From a statement made at Edinburgh Council meeting, the other day, by the convener of the Electric Lighting Committee, it would appear that every precaution is being made there to prevent explosions. The convener seems to have thoroughly grasped the circumstances attending these explosions, and he explained the matter very concisely.

In regard to the explosion which occurred in Market Street, Leicester, on 13th inst., the electric lighting and gas engineer, Mr. Colson, has now submitted his report. In his judgment, the explosion was caused by an electric arc being formed between the terminals in the high tension junction box, and the consequent gasifying of the oil used in the box as the insulating medium. Owing to the explosion it has been decided to substitute specially prepared wax for the oil at present in use in the various transformer chambers in the town. Hitherto the explosions which have from time to time occurred in different parts of the country in connection with electric lighting installations have been attributed to the presence of coal gas, but in the case of the Market Street explosion, Mr. Colson is confident the coal gas had nothing whatever to do with it, but that the explosion was owing to the oil employed becoming converted into gas by the electric current forming an arc in the way stated.

The Rochester Gas and Electric Company, of New York State, have in use on their system 151 manholes. They have tried stand pipe ventilation, and find they have better success by using perforated covers to the manholes. They are now

changing covers to the latter style. In all their manholes they have trap drains into the main sewers; therefore they are not now bothered with water in the manholes.

A correspondent writes:—"I notice in the *Times* and *Daily News* of Monday last the account of two more explosions in electric light mains. This is to be regretted although there is little doubt that they were caused by an escape of gas from the mains in the street. It appears these explosions are more frequent during the winter months, if so, there must be a cause and the following may be worth consideration. If an explosive mixture of gases is formed from moisture, decomposition, condensation, &c., owing to insufficient ventilation, could not its composition be ascertained by chemical analysis of the air taken from the culverts and junction boxes, not from London alone, but from different parts of the country? Would the presence of an electric current accelerate the formation of explosive gases? Again, would the removal of the lids of junction boxes for a time dispel an accumulation of gas, when probably the temperature in the culvert is higher than the external atmosphere, or help to make it more dangerous? There is apparently some doubt as to how the gas ignites. A lighted match carelessly thrown down has caused explosions of gas underground, would it be possible to explode an accumulation of gas in culverts by a light from consumers' premises where the service enters?"

Electrical Transmission of Power.—It may be interesting to those who are watching the development of electrical transmission of power in engineering works, to know that Messrs. Greenwood & Batley, Limited, have secured from a foreign government a large order for machine tools with electric motors combined.

Vacancy at Cardiff.—The Corporation want a practical man to take full charge of their electric lighting station, under the general supervision of the Borough Engineer, and are inviting applications up to the 7th inst. Salary £200 per annum. Full details to be obtained from Mr. Harpur, the Borough Engineer.

NEW COMPANIES REGISTERED.

Evershed & Vignoles, Limited (43,206).—This company was registered on February 5th with a capital of £10,000, in £10 shares, to carry on the business of engineers and manufacturers in all its branches, and to manufacture, repair, buy, sell, hire, let, and otherwise deal in or with any machinery, implements, instruments, and other apparatus and appliances. The subscribers (with one share each) are:—Sydney Evershed, 1, Woodfield Road, Harrow Road, W., electrical engineer; Ernest B. Vignoles, 28, Lanhill Road, W., electrical engineer; Rev. O. J. Vignoles, M.A., Athenæum Club, S.W.; Mrs. O. J. Vignoles, 46, Upper Gloucester Place, N.W.; Adolph Schneider, Ferndale, Kew Gardens, electrical engineer; Frank Evershed, Hayes Lane, Kenley, Surrey, analytical chemist; John Evershed, Kenley, Surrey, manufacturing chemist. There shall not be less than two, nor more than five directors; the first are Sydney Evershed, Ernest B. Vignoles, Horace M. Gregory, and William E. Ayrton; qualification, the holding of shares on which all calls have been paid; remuneration as fixed by the company. Sydney Evershed and Ernest B. Vignoles are to be the managing directors for five years. Registered office, 1, Woodfield Road, Harrow Road, W.

Pearson's Automatic Fire Indicator Company, Limited (43,223).—This company was registered on February 6th with a capital of £5,000 in £1 shares, to purchase the inventions of Richard Pearson for the manufacture of a thermometric circuit closer used as a fire alarm and indicator, for which provisional protection has been obtained by provisional patent, No. 5,650 of 1894, and to carry on the business of an electric instrument and apparatus company. The subscribers (with one share each) are:—E. K. Burstal, 40, Hopton Road, Streatham, M.Inst.C.E.; M. H. Winkley, 2, Great St. Helens, E.C., wharfinger; E. H. Hubble, Sherley House, Lee, S.E., gentleman; E. Mann, Palace Chambers, Westminster, clerk; C. E. Masterman, Northwood, Middlesex, Assoc.M.I.C.E.; P. Greville, Osmanthorpe, Laleham, electrician; J. Speer, 27, Leadenhall Street, E.C., clerk. There shall not be less than three nor more than five directors. The first are—Edward K. Burstal, Edwin H. Hubble, Edward Mann, Edmund H. Stevenson and Mark H. Winkley. Qualification 100 shares; remuneration none, unless £10 per cent. per annum is paid as dividend; then £25 each per annum for every 5 per cent. of dividend paid. Registered by Payne & Lattey, 27, Leadenhall Street, E.C.

Electric Guest-Call Company, Limited (43,229).—This Company was registered on February 7th with a capital of £5,000 in £1 shares (1,500 "A" and 3,500 "B" shares), to adopt an agreement dated January 2nd, between Arthur J. Benedict of the one part, and De La Montagnie Moore (for the Company) of the other part, and to carry on the business of manufacturers, and suppliers of, and dealers in, and contractors for the sale, purchase, letting, erection and maintenance of electrical and mechanical machines and apparatus, particularly those connected with the production of calls and announcing clocks for use in hotels, clubs and similar establishments. The subscribers (with one share each) are:—D. L. M. Moore, 133, Cannon Street, E.C., agent; H. E. Gibbins, 31, Silvester Road, E. Dulwich, clerk; A. Watkins, C.A., 24, Queen Victoria, E.C.; A. A. Heron, 12, Broadesbury Road, N.W., secretary; J. E. Moore, 22, Manchester Street, W., agent; E. H. Edwards, 48, Pellerin Road, N., Clerk; W. C. Greenop, jun., 9, Gracechurch Street, E.C., Solicitor. The number of directors is not to be less than three nor more than five, the first are to be elected by the subscribers; remuneration £50 each per annum, and £50 extra for the chairman. Registered by Greenop & Sons, 9, Gracechurch Street, E.C.

Parish Lighting Company, Limited (43,233).—This company was registered on February 7th with a capital of £15,000, in £5 shares, to light with gas, electricity, oil, or other illuminating means or appliances, the roads, streets, houses, buildings and open spaces in the township of Chester-le-Street, in the county of Durham, and that immediate neighbourhood. The subscribers (with one share each) are:—J. W. Luccock, The Deanery, Chester-le-Street, confectioner; W. Mitchell, High Street, Chester-le-Street, provision merchant; J. C. Hetherington, High Street, Chester-le-Street, draper; R. Wilson, High Street, Chester-le-Street, hotel keeper; J. Mitchell, Claremont Villa, Chester-le-Street, gentleman; W. Clarke, High Street, Chester-le-Street, ironmonger; G. W. Barker, High Street, Chester-le-Street, insurance agent. The number of directors is to be seven. Qualification, 50 shares. Registered by Waterlow Bros. and Layton, Birchin Lane, E.C.

Vaughan & Brown, Limited (43,247).—This company was registered on February 9th with a capital of £40,000, in £5 shares (of which 4,000 are preference), to acquire and carry on the business of electric light, gas, hot water, sanitary and ventilating engineers, art metal workers, and electricians, carried on by Vaughan and Brown, of 15, 16 and 17, Kirby Street, Farringdon Road, E.C., and to adopt three agreements for that purpose. The subscribers (with one share each) are: T. W. Vaughan, 15, Kirby Street, E.C., engineer; G. C. Vaughan, 15, Kirby Street, E.C., electrical engineer; A. R. Pilkington, Shardcroft Avenue, Herne Hill, S.E., Lieut.; P. W. Hastings, 20, Acacia Grove, West Dulwich, C.E.; S. J. Pemberton, 36, Hornsey Park Road, N., engineer; A. Young, 68, Park Road, N., designer; W. Cook, 189, Graham Road, N.E., book-keeper. The number of directors is not to be less than three, nor more than five; qualification, £100; remuneration, £200 each per annum. Registered by Sutton & Co., 3 and 4, Great Winchester Street, E.C.

Alliance Meter Company, Limited (43,295).—This company was registered on February 15th, with a capital of £5,000, in £1 shares, to carry on the business of manufacturers, importers, exporters, and vendors and dealers in gas meters, water meters, and electric light meters, and apparatus, appliances, and fittings connected therewith, and to adopt a certain agreement. The subscribers (with one share each) are:—G. Gray, 14, Addison Gardens, W., gentleman; W. Coward, 119, High Street, Kensington, barrister; A. C. Gray, 35, Tankerville Road, S.W., accountant; J. Clark, Wood Green, clerk; H. C. Knight, 2, South Square, Gray's Inn, solicitor; H. P. Beecher, 26, Bedford Row, W.C.; H. G. Clark, Penge, S.E., clerk. The number of directors is not to be less than two nor more than three; qualification, 100 shares; remuneration as fixed by the company. Registered office, 9, London Street, E.C.

Battery and Motor Company, Limited (43,309).—This company was registered on February 16th, with a capital of £12,000 in £5 shares, to acquire certain patents for improvements in primary batteries and motors, to adopt a certain agreement, and to manufacture, work, use, let on hire, and sell electric batteries, machinery, boats, vessels, apparatus, &c. The subscribers (with one share each) are:—J. T. Pitt, 19, Disraeli Road, Putney, gentleman; G. Brown, 77, Rectory Road, N.E., agent; S. B. Saunders, Catford, S.E., accountant; H. N. Godward, St. Margaret's Mansions, S.W., secretary; A. J. Coole, 53, Victoria Street, S.W., accountant; H. S. Bourke, 39, Victoria Street, S.W., accountant; J. R. Pike, 25, Austin Friars, E.C., solicitor. The number of directors is not to exceed seven nor be less than three. Qualification 20 shares. S. B. Saunders and H. T. Barnett are managing directors, with a salary of £250 each per annum and a percentage of the profits. Registered by Marriman & Co., 25, Austin Friars, E.C.

W. & J. Robinson & Co., Limited (43,339).—This company was registered on February 20th with a capital of £40,000, in £5 shares, to acquire and take over as a going concern the business of electrical and general engineers now carried on by Wm. H. Robinson and Jno. L. Robinson at 103, Balliol Road, Bootle, near the City of Liverpool, as "W. & J. Robinson & Co.," to adopt an agreement dated February 16th, 1895, between said vendors, of the one part, and Geo. S. Oldham (for the company) of the other part; to carry on the business of an electric light company in all its branches, and to carry on the business of electricians, electrical engineers, &c. The subscribers (with one share each) are: W. H. Robinson, 103, Balliol Road, Bootle, electrical engineer; J. L. Robinson, 103, Balliol Road, Bootle, electrical engineer; Wm. Poulsom, 48, Town Buildings, Liverpool, merchant; Wm. Thomas, 30, Brunswick Street, Liverpool, shipowner; Jas. Eastham, Edenfield House, Ormskirk, gentleman; Alfred Rowland, 15, Fenwick Street, Liverpool, shipowner; Wm. A. Weightman 6, Water Street, Liver-

pool, solicitor. The number of directors is not to be less than three nor more than five; the subscribers will appoint the first directors; qualification, £500; remuneration as fixed by the company. Registered by Walker, Son & Field, 61, Carey Street, W.C.

Aroscopic Lens Company, Limited (43,321).—This company was registered on February 18th, with a capital of £1,000 in £1 shares, to manufacture, sell, and deal in electrical, medical, or optical instruments, discoveries, inventions, and devices, and to act as merchants, advertising agents, printers, publishers, &c. The subscribers (with one share each) are:—J. T. Higginbottom, 7, Florence Road, N., clerk; H. J. Smith, 23, Leatherdale Street, E., accountant; J. Herbert, 20, Bucklersbury, E.C., lithographer; H. Mobbs, 3, Elmar Road, N., stationer; A. Marshall, 46, Fairfax Road, N., architect; E. Piercy, 20, Fentiman Road, S.W., clerk; J. S. Marsden, 137, Sebert Road, E., architect. Registered without articles of association by J. B. Purchase, 11, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Coventry Electrical Engineering Company, Limited (41,936).—The statutory return of this company, made up to January 23rd, was filed on January 28th. The capital is £5,000 in £1 shares, and 1,766 of these have been taken up; 801 have been issued, with £679 considered as paid; £1 per share has been called on 220 shares, and 15s. per share on 745 shares. The calls paid amount to £776 10s., leaving £2 5s. in arrears. Registered office, 17, Hertford Street, Coventry.

Madras Electric Tramways Company, Limited (36,158).—The annual return of this company, made up to December 27th, was filed on January 5th. The capital is £100,000 in £1 or Rs. 15 shares. 34,077 £1 and 47,066 Rs. 15 shares have been taken up, and 19,650 of the former have been issued as fully paid. The full amount has been called on the others, resulting in the payment of £54,128 9s. 3d., and leaving £7,364 10s. 9d. in arrears. £600 has been paid on 1,500 forfeited shares. Registered office, 1, Trafalgar Buildings, Northumberland Avenue, London, S.W.

Charles Churchill & Co., Limited (29,931).—The annual return of this company, made up to December 10th, was filed on the following day. The capital is £6,000, in 140 preference shares of £25 each and 50 ordinary shares of £50 each. 129 preference and 40 ordinary have been issued as fully paid. The full amount has been called, and £1,975 paid on 79 preference shares. Registered office, 21, Cross Street, Finsbury, London, E.C.

Crossley Telephone Company, Limited (20,044).—Special resolutions have recently been passed for the voluntary winding-up of this company, and for the appointment of Henry E. Jeffree, of 30, Hallfield Road, Bradford, as liquidator, at a remuneration of £5.

Chelmsford Electric Lighting Company, Limited (36,124).—The annual return of this company, made up to January 1st, was filed on January 21st following. The nominal capital is £10,000, in £1 shares (of which 7,500 are preference, and 2,500 ordinary). 5,507 preference and 2,378 ordinary have been taken up, and the full amount called. £7,878 has been paid, leaving £7 unpaid. Registered office, Arc Works, Chelmsford, Essex.

Cowper-Coles Galvanising Syndicate, Limited (41,223).—The statutory return of this company, made up to September 14th, has just been filed. The capital is £2,000, in 500 "A" and 1,500 "B" shares of £1 each. All the "A" and 607 "B" have been taken up, and 500 of each class issued as fully paid. The full amount has been called and paid on the remainder. Registered office, 39, Victoria Street, S.W.

Coventry Electrical Tramways, Limited (38,821).—The annual return of this company, made up to January 12th, was filed on January 26th. The capital is £25,000, in £5 shares, and seven shares have been taken up, and the full amount called and paid.

Electrical Advertising Syndicate, Limited (33,896).—The yearly return of this undertaking was filed on January 18th, when 964 £10 shares were taken up out of a capital of £10,000, 900 have been issued as fully-paid, and the full amount has been called and paid on the remainder.

Electric Fittings, Hiring and Maintenance Company, Limited (35,551).—The annual return of this company, filed on December 22nd, shows that only seven shares have been subscribed for out of a capital of £200,500, in 40,000 £5 and 500 £1 shares.

Edmondson Electricity Meter Syndicate, Limited (41,756).—The statutory return of this company, made up to December 21st, was filed on the following day. The capital is £2,000 in £1 shares, of which 175 shares have been taken up; £7 has been paid, and the remaining 168 shares have been considered as paid.

Electric Novelty Syndicate, Limited (41,440).—The statutory return of this company, made up to November 9th, was filed on January 24th. The capital is £4,500 in £1 shares, and 992 of these have been taken up. The full amount has been called, and £960 has been paid, leaving £32 as yet in arrears.

Electrical Coal-Cutting Corporation, Limited (36,643).—In the annual return, filed on December 20th, we find that 60,000 £5 ordinary, 20,000 £5 deferred, and 2,000 £1 founders' shares constitute the capital of £402,000; 9,531 ordinary, and all the deferred and founders' have been taken up, and the deferred, and 4,000 ordinary shares have been considered as fully-paid; £5 per share has been called on 5,531 ordinary, and £1 per share on the founders' shares, and the payments total £28,375, leaving £1,280 still in arrears.

Electric Light Regulating Syndicate, Limited (38,705).—The statutory return of this concern, made up to and filed on January 2nd, shows that 805 shares have been allotted out of a capital of £1,000 in £1 shares. 625 shares have been issued as fully paid, and the £1 per share has been called and paid on the remainder.

Municipal Electric Light and Power Corporation, Limited (29,091).—This corporation's yearly return, which was filed on January 3rd, announces the fact that 37 ordinary and 30 founders' shares have been taken up, out of the capital of £25,000, in 100 founders' £1 shares and 2,490 ordinary £5 shares. The full amounts have been called, and £400 paid.

County of London and Brush Provincial Electric Lighting Company, Limited (34,320).—The yearly return of this undertaking was presented for filing on December 8th. The capital amounts to £800,000, in 40,000 ordinary and 40,000 preference shares of £10 each; 20,000 ordinary have been taken up, and have had a call of £6 per share made. All of this has been received, together with £1,436 paid in advance.

Electric and General Contract Corporation, Limited (37,623).—The yearly return of this Company was filed on January 30th, when 1,000 deferred and 805 preference shares were taken up. 799 of the former have been considered as fully paid, and £5 per share has been called on the rest, and the full amount received. It may be mentioned that the capital is £50,000 in £10 shares, of which 9,000 are preference and 1,000 deferred.

Electric Meter Company, Limited (31,096).—This Company's annual return was filed on January 9th. The capital is £50,000 in £10 shares, and 2,007 of these have been allotted. Of these 2,000 were issued as fully paid, and £30 has been received in respect of the other shares, leaving £40 unpaid.

Mildé Telephones and Electric Supply Company, Limited (40,384).—The annual return of this company, filed on December 21st, shows that only the seven original subscribers' shares have been taken up, out of a capital of £20,000 in £1 shares, and no calls have been made.

Chemical and Electrolytic Syndicate, Limited (39,525).—This company has recently filed its annual return, which shows that 4,411 shares have been taken up out of a capital of £30,000 in £5 shares. 3,279 have been issued as fully paid, and the remainder have had £3 per share called. £3,195 has been paid, leaving £201 unpaid.

Okonite Company, Limited (31,782).—The annual return of this company, made up to January 10th, was filed on January 14th, 1895. The whole of the nominal capital of £340,000, in 17,000 preference and 17,000 ordinary shares of £10 each, has been taken up, but five preference have been forfeited. 5,666 ordinary and 5,666 preference have been issued as fully paid, and the full amount has been called on the remainder. £225,665 has been received, and £1,015 is still unpaid.

Pacific and European Telegraph Company, Limited (36,683).—The annual return of this company, made up to December 26th, has recently been filed. The capital of £100,000, in £10 shares, has all been taken up, and a call of £4 per share made. The calls paid amount to £37,500, and £2,500 still remains unpaid.

Pioneer Electric Carriage Company, Limited (39,009).—The annual return of this company, made up to January 3rd, was filed on January 10th. The capital is £20,000, in £50 shares, and 52 have been taken up. The full amount has been called, and £1,540 paid, with £1,060 in arrears.

Electrolytic Caustic Soda and Chlorine Trust, Limited (34,220).—The annual return of this company, made up to December 27th last, was filed on January 1st. The capital is £20,000 in £10 shares, and it has all been taken up. 500 have been issued as fully paid, and the full amount has been called and paid on the remainder.

S. Z. de Ferranti, Limited (31,808).—The annual return of this company, made up to January 14th, was filed on January 21st. The capital is £100,000 in 2,000 preference and 8,000 ordinary shares of £10 each, and it has all been issued as fully paid, with the exception of seven preference shares, on which £70 has been paid.

Railway Automatic Electric Light Syndicate, Limited (28,332).—The annual return of this company, made up to December 31st, was filed on January 15th. The capital of £25,000, in 400 ordinary and 600 preference shares, has all been taken up, but four shares have been forfeited. 200 ordinary have been issued as fully paid, and the full amount has been called on 200 ordinary and 550 preference, while 50 preference have had £20 per share called. The calls paid amount to £18,103, and £1,592 is unpaid.

Queen Anne's Mansions Lighting and Heating Company, Limited (34,272).—No change has taken place in the return of this company, which was filed on January 23rd, as the whole capital of £60,000, in £10 shares, has been issued as fully paid.

Rollason's Wind Motor Company, Limited (38,794).—The annual return of this company, made up to January 4th, was filed on January 14th. The capital is £35,000, in £1 shares, of which 350 are founders'. All the founders', and 24,133 ordinary, have been taken up, and the former, with 22,350 of the latter, were considered as paid. The full amount has been called on 717 shares, and 5s. on the remainder. The calls paid amount to £701 12s. 6d., leaving £281 17s. 6d. still in arrears.

Pyke, Harris & Co., Limited (37,917).—The annual return of this undertaking, made up to January 11th, was filed on the 23rd of the same month. The capital is £30,000, in 1,400 "A" and 4,600 "B" shares of £5 each; 3,600 "B" shares have been taken up, and issued as fully-paid; 1,218 "A" shares have been taken up, and the full amount has been called and paid.

Reading Electric Supply Company, Limited (35,651).—The annual return of this company, made up to December 31st, was filed on February 13th. The capital is £75,000 in £5 shares, and 2,719 have been taken up. The full amount has been called on seven shares, and £4 per share on 2,712. The calls paid have realised £10,481, with £402 as yet to be paid.

CITY NOTES.

The Kensington and Knightsbridge.

THE analysis of this company's year's working, which we append herewith, is altogether an admirable one. As we noted in our issue of the 15th ult., there has been a satisfactory increase all round. The average annual consumption per 8-C.P. lamp was always rather low on this company's mains, but we notice that the increase in the lamp connection has brought little falling off in the consumption per lamp. The company is fortunate in its staff; it is something to be able to show such fine results; when with this is coupled such resource as was shown at the recent fire, we think the company doubly fortunate:—

	1892.	1893.	1894.
Total capital invested	£152,217	£175,927	£187,300
Number of units sold	535,343	724,308	977,797
Number of lamps connected ...	47,441	64,529	80,678
Revenue from sale of current ...	£16,235	£20,746	£24,738
Net revenue	—	—	£9,289
Average price obtained per unit..	7·44d.	6·87d.	6·09d.

Cost of production.	£	s.	d.		Per unit.
Coal	2,929	5	6		·72d.
Oil, waste, water and engine room stores	598	15	0		·14d.
Salaries and wages at generating station	2,443	7	8		·60d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,641	11	3	(Works cost 2·11d.)	·65d.
Rates and taxes	736	12	6		·18d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	2,317	4	9		·56d.
Depreciation of buildings and plant account	1,802	0	0		·44d.
Renewal fund account	3,457	5	9		·85d.
Total	£16,926	2	5		4·14d.

Revenue.				Average price obtained per unit.
By sale of current	£24,738	19	6	—
Meter rents	985	7	0	6·09d.
Total	£25,724	6	6	6.09d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·85d.; works cost, 2·11d.

Chelsea Electricity Supply Company.

THE report and accounts of this company have been issued. There has been a considerable expenditure during the year, amounting to some £20,222. Apparently this has been devoted to modernising the plant at the Cheyne Walk Station, which was acquired in 1893. Taking into account the additional plant which has been provided, the increase in the lamp connection has not been very conspicuous; still it is a substantial one, and is quite as good as the one of the previous year.

Mr. Cluer has been good enough to send us the figures, which will enable us to analyse the cost per unit, but we shall hold these over till next week.

The balance of premiums on the preference shares, issued in April last, amounting to £1,339, has been applied to the reduction of the preliminary expenses account. The revenue account shows a credit balance of £8,096. After deducting interest on debentures and sums placed to renewals and depreciation funds, the remainder is to be applied to a payment of dividends of 6 per cent. on the preference shares and of 5 per cent. on the ordinary shares.

The Charing Cross and Strand Electricity Supply Company.

WE can heartily congratulate the company on its exceedingly low working costs, notwithstanding the heavy item for coal. One feels tempted, of course, to make comparisons with other companies, but though this is easy, such comparisons are not very safe, unless one takes into account the varying conditions applicable to each company. Still, the results of the Charing Cross Company are admirable, and if Mr. Patchell is not suffering from a surfeit of compliments, he may allow us to congratulate him.

	1892.	1893.	1894.
Total capital invested	£198,773	£205,854	£211,762
Number of units sold	652,703	934,276	1,115,609
Number of lamps connected ...	31,990	34,570	41,216
Revenue from sale of current...	£19,717	£20,597	£23,521
Net revenue	—	—	£10,395
Average price obtained per unit	—	—	5·06d.

Cost of Production.	£	s.	d.		Per unit.
Coal	4,918	11	9		1·06d.
Oil, waste, water, and engine room stores	611	11	0		·13d.
Salaries and wages at generating station	2,501	19	6		·54d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	1,794	18	8	(Works cost 2·11d.)	·38d.
Rates and taxes	410	1	0		·09d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,783	15	11		·38d.
Depreciation of buildings and plant account	2,085	0	3		·45d.
Renewal fund account	—				—
Total	£14,105	18	1		3·03d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	23,521	15	10	—
Meter rents	287	13	7	5·06d.
Sale of Lamps	70	10	8	—
Total	£23,870	0	1	5·06d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·57d.; works cost, 2·11d.

City of London Electric Light and Power Company, Limited.

THE ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Wednesday, Sir David Salomons in the chair.

The SECRETARY (Mr. Cecil Bull) read the notice convening the meeting.

The CHAIRMAN, before commencing his speech, handed round photographs of the works. He then said: At the time of year when the days were gloomy, and minor troubles enter the household, it was then, as the directors of the company, that they rejoiced. They were not a medical association, nor were they undertakers to supply funerals cheap and effective, but it was at this time of the year that they could bring light and happiness to many a home and into many an office. They suffered from a disadvantage which had been already recognised by many companies; it was that they had to buy materials which were adulterated, and for want of scientific knowledge—which might come in the future—they were unable to give it to the public in an adulterated state. Moreover, it was as well for their customers to know that they could not get condensation in the mains to impede its delivery, nor get frozen in the pipes so that the delivery was stopped. Considering the absence of fog which had prevailed during the year under review, and the end of the previous one—it was rather exceptional for London to be so free—they had done exceedingly well, and if the affairs of the company were to be reviewed by an impartial critic—he did not consider himself one—they could only come to the conclusion that they were giving a satisfactory supply, and that the organisation was in a satisfactory state. They must remember that this was a new illuminant, very few years old, and really introduced into the City of London as late as two or three years ago as a regular supply. When they remembered that they were now raising a gross income of something like £114,000, the view that he was taking—or the one that should be taken by an impartial critic—was a fair one.

On previous occasions it had been his necessity—he would not say duty—to make an excuse to them for not giving a dividend to the ordinary shareholders; but the difficulty of teaching the public to appreciate a new undertaking was great. No undertaking could pay on the ordinary shares at the commencement; it was necessary that the work should be completed, and the *clientèle* obtained before obtaining one sixpence in return. He did not think that any gentleman could complain that he had made promises which could not be fulfilled; it was not his principle of life to make promises unless he could see that they were to be carried out. The ordinary shareholders had shown patience and indulgence towards the directors, and the time for recompense had arrived. They had turned the corner, and a corner which he hoped they would never go back on. It made it, under those circumstances, a very easy matter to address them, for the reception of a little money in their pockets was an agreeable thing, whether they were rich or poor, and only good temper could prevail. They had now begun to pay a dividend, not a mean one, of 5 per cent. to the ordinary shareholders, and he trusted that they would never meet in the future without declaring a sum as large as that. He could save their time at this stage by sitting down, but it was their wish, and always had been, that what took place in the company should not be limited to the shareholders alone, but should be circulated outside, so that their friends and neighbours in the same business might learn a little from them as they had done from others, he thought men of business with liberal views would always take that course. He would not attempt to run through all the various figures in the report, though he might have to refer to one or two.

The Staff.

He would point out that the chief alteration made in the staff since they last met was that of the appointment of Mr. Frank Bailey as the chief engineer. He thought that they had to congratulate themselves very greatly upon that appointment. It was not without considerable trouble that they obtained that gentleman's services; they had greatly benefited already. He was too well known throughout the whole world for him to make any further remarks on his (Mr. Bailey's) qualifications.

The Growth of the Company.

On page 3 of the report they would see the growth of the company. Taking customers from 1892, when they stood at 242, to the end of December, 1893, they were 1,080, while at the end of 1894, they stood at 2,740. They must not imagine, however, that that increase would go on for ever; it showed at any rate that the citizens of London were appreciative of their efforts to bring comfort and health into their offices. The most severe critic who analysed their accounts could not say otherwise than they were honest. In the first place, the form in which they were placed was one in which they exercised no option. It was the Board of Trade form, and the figures had to be filled in in accordance with their rules on the subject, with the exception of certain apportionments which the directions alone could apportion; in order to correct the board the auditors go through every item to satisfy themselves. The accounts contained one or two very important points which might have escaped their attention. In the first place, they would notice that the lump sum of £19,064 18s. 4d. under liability had been written off in order to pay all expenses of issue of the various classes of shares and debentures. It was a very common practice to write these off by degrees, but the directors thought fit to take it out of the balance-sheet, as they could afford to do so easily. The ordinary shareholders had sacrificed a good deal in permitting the board to issue preference shares and debenture stock at a higher interest than what might have been possible and convenient. By doing that they were enabled to secure the issue at a premium, which had enabled them to put by a very large sum for reserve fund. Having made that sacrifice for a reserve fund, firstly writing off the whole of the expenses of the issue at once, the directors thought it was perfectly right that the sum of £1,589 should be paid out of premiums to the reserve fund, this being the 5 per cent. reserve fund which it was necessary to put by, apart from the other depreciation fund. The auditors fully concurred in that. He was sure the shareholders would uphold them as doing right in the matter. The reserve and depreciation funds were not idle money, because it bore interest which went to assist the dividends of the ordinary shareholders. The funds consisted of £40,000 in consols, which were purchased at $98\frac{7}{16}$, which at the time of purchase was the average price; this had increased owing to the greater value of consols; they had the sum of £15,000 in the Metropolitan 2½ per cent. Consolidated stock. The actual value represented, in round numbers, about £56,000; to this had to be added the balance of premiums on the last issue of debenture stock, which made a total of about £90,000. He trusted they were in a very safe position for the future, as their income was likely to meet all requirements without trenching upon the above sum, or, at any rate, only to a nominal extent from time to time. He thought they would agree with him that the rapid extension of the company's business showed that the public was satisfied with their efforts. They were now just over 3½ years old; for 18 months they were occupied in getting things ready. One trouble they had to contend with had been the condensing plant. It should have been ready long ago; indeed, it was ready, but when the pumps were set to work it was found that the strainers became fouled, and no water could be drawn. This was due to the river being full of straw and other things; they were, however, now putting in machinery to clear the strainers. When it was ready, which would be soon, it would be of great advantage in lightening the coal bill, as well as decreasing the amount of steam, which must naturally issue from the works when they had no condensing plant. Equal satisfaction must be felt with regard to public lighting, for the reason that the gas lamp-posts in the main thoroughfares were removed soon after the last year's meeting. No one had ever criticised the lighting of the City without expressing an opinion complimentary to them. To give a simple notion of how that was working, he would say that the total breakdowns had been six, that is, a few lamps at a time, here and there, the total extinction being under three hours; the number of lamp hours were considerably over two millions, the percentage of lamps being out was 0·067 per cent. The private lighting had also been satisfactory, the total extinction being 0·012 per cent. of the lighting hours, which was very small. Their engineer had suggested to the board a method of giving discounts, whereby the small customers would be reached. The difficulty they had always had was that the discounts, as was generally done, were given to the wealthy people, and the small ones got nothing, or, at any rate, a very small amount. They had now, however, found a very simple and very convenient method of giving discounts to small customers, one advised by Mr. Frank Bailey, which would, he thought, give satisfaction to everyone within the City boundary; they would be a friend not only of the rich man, but of the poor. They hoped soon to receive orders from the City authorities to light the lesser streets, as they were termed in the contract, the delay of the order had been due to experiments having been made and not being passed; they were, however, now urging the City authorities to settle on some system for lighting the minor streets, and they hoped it would be settled in a very few months, and would not appear as a promised order in future reports. There was one point of great importance to them, although to some it might appear a small matter. Next door to their works there existed an enormous oil store; if this had caught fire their works would have been destroyed. That was not only dangerous to their property, but also to their customers and to the City of London generally, for the supply of electricity might have been cut off. In the face of that, the board resolved to purchase these works on reasonable terms. This they had been able to do at a very fair figure, and the oil store had now disappeared. These works were not an imaginary advantage to them, for, apart from removing the great danger, the land running alongside their own enabled them to put there such offices as may be required to supplement those they had; it would save them considerable expense in renting places elsewhere. No doubt they were aware that three months ago they gave a dinner to the Lord Mayor and a large number of persons connected with the industry; that dinner was cooked entirely by electricity, the intention being to show that cooking by electricity was practical; they showed that, and they also drew great attention to the company, and he trusted that the money spent in that way had not been without successful issue. Although it was very difficult to trace how many pounds had come to them through that dinner, it had been, on the whole, beneficial to them.

Prevention of Smoke.

All their boilers, with few exceptions, had been fitted with automatic stokers, and their second chimney shaft was in use. Since that time they had not been troubled with complaints about smoke nuisance. He had watched those chimneys continually, and they could compare with many of the factories round who had not got similar arrangements. When they considered that they had machines requiring thousands and thousands of horse-power, which needed a gigantic consumption of coal, there was very little more smoke than that from a few fires in ordinary houses.

Present Position.

The plant in position is equal to 121,000 8-C.P. lamps, and there was on order plant equal to 120,000 8-C.P. lamps. These figures may not seem to tally with other figures showing the number they had connected. They had never had so many as 80 per cent. lighted at one time; they had plant sufficient to cope with 157,000 to 160,000 lamps connected, remembering that they were not all in use at one time. It was rather misleading to state the length of cables, because some of them were double and triple concentric; the total length of trench now in use was 63 miles, the total length of cable ways laid was 216 miles, the high tension mains were 110 miles, and the total length of distributors about 43 miles, which, put into more ordinary language, was equal to about 40 miles of house frontage. That gave roughly an idea of the state of the mains at the present time. He would give a few technical figures, not so much for the shareholders, as those outside. The number of units used in private lighting for 1894 was 1,532,396, for public light very nearly a million units, there being about 73,000 units used at the works for lighting and testing, and would be very much lighter when the testing work was decreased. Altogether there were 2,602,607 units sold during 1894, as against 1,741,099 in 1893. The ratio of generation and distribution to receipts were 46 per cent. He could not guarantee that figure to 1 per cent.; that figure in 1893 was 54·2 per cent. That showed that the working expenses went down as the output increased, but as the machinery in course of meeting the demand would depreciate, they must not expect therefore that the output would go on increasing till it was all profit. It showed that they had been improving for years, and he hoped they would go on improving for some years to come. By the report they would see that for 1894 50·27 per cent. might be taken as profit, whereas in 1893 it stood at 40·11. The figures again were better for private lighting if taken alone, but he thought it was fairer to show the figures *en bloc*. As years went on they would be able to make a better per cent. The proportion of profits for 1894 had, roughly, been better by 10 per cent. than that of 1893. The coal consumption for the year stood at 1¼d., but if taken at the best time of the year, it was considerably under 1d., being about 9d. As the load increased in summer, it would be under 1d. for the whole year. That was not anything great; they ought to be able to work a shade under 1d, and it was their endeavour to do as well as other people. The average price obtained per unit was 7·7d. The total number of lamps was 144,086, and they had still 7,677 to connect, and applications came in very

satisfactorily, averaging about 1,000 per week; he hoped that would continue for some years, but no one could hope for it to continue for many. They still had powers to issue debenture stock, and that would be required to extend the works; they had only powers to issue £400,000. They had issued the last at a premium, but they had come to a standstill unless they (the shareholders) sanctioned another £100,000. He should ask them to by-and-bye; this would make, roughly, half-a-million, of which sum £90,000 they had by them as sinking and reserve fund. After referring to the retiring directors, the chairman, in conclusion, said they owed a debt of gratitude to the staff. He then moved that the accounts and report be adopted.

Mr. Braithwaite, in seconding the adoption of the report, said they had come to the point which some of them had always been confident they would, of being in a position to pay a dividend on the ordinary shares. Some of them who put their money into the company at the end of 1890 were rather laughed at; they were told that they did not know what they were doing, that the idea of making electricity supply pay in the City of London was ridiculous. Their friends kindly gave them two years in which to lose their money. Some of them, however, thought that the City of London offered exceptional advantages for a thoroughly well-managed electric lighting company, and experience had shown them that so far from the lamps in the City of London earning less revenue than the lamps of other companies had, up to the present time the City lamp earnings were, if anything, considerably ahead of any other company in London. Without egotism, they might say that the City of London was the wealthiest city in the world, and they had therefore a class of customers to deal with to whom a question of £3 or £4 extra for lighting was of no moment whatever, compared with the question of comfort and convenience. Therefore, he thought they might fairly congratulate themselves, because with the comparatively small number of lamps which they had connected at the end of 1894, they had not only earned their debenture issue, but a dividend at the rate of 5 per cent. on the ordinary shares. Naturally they would ask what were the prospects for the future. They were entirely satisfactory. They had at the moment 140,000 lamps, as against 65,000 last year; if 65,000 lamps would earn all the preference and debenture issue, he would leave them to figure out what it would be with a greater number. They had always laid their plans for meeting a demand of 400,000 lamps; as to whether these would be realised it was unsafe to prophecy, but the 1,000 lamps increase per week was as many as they cared to have. He next referred to the forbearance of the ordinary shareholders, and spoke of the advantage of issuing the last debentures at a premium, thereby wiping out preliminary expenses, and helping to swell the reserve fund. The company had now got out of its infancy, and had entered upon a vigorous youth, to be followed by a hale and hearty old age. The shareholders had conferred a great benefit on the City of London, and he hoped without ultimate injury to their pocket.

The Chairman inviting questions,

Mr. Wancke, a shareholder, asked about the telephone tubes.

Mr. Sydney Morse spoke of the explosions, and the responsibility of the gas companies.

Mr. Backshell asked if the non-fulfilment of the contracts for lighting the lesser streets affected the company.

A Shareholder asked if it was true that they intended to reduce the price of current.

The Chairman said they were not going to reduce the price; they were going to give discounts.

The Shareholder said it was the same thing.

The Chairman, in reply to the whole of the questions, said he did not put the affairs of the company before them in so liberal a spirit as Mr. Braithwaite. He fully shared his views, but it was never wise to be too sanguine. Mr. Braithwaite took a most sanguine view, and had been hitherto right in all his prophecies. With regard to the question of the telephones, he could give no better answer than by referring the enquirer to the newspapers. They knew that from time to time the Commissioners had considered the question, but the matter got continually shunted. He trusted that eventually they would obtain what they fairly asked for.

A Shareholder: It is a question of price.

The Chairman said they were dealing with the Commissioners, and it might be unwise to say anything on that point; they had made a very liberal offer, and he did not think there was any question at all on that score. The explosions were well under discussion and consideration of the Board of Trade, and he did not think it would be right for them to analyse what may be done until they knew what was to be done. As far as they were concerned, they were doing everything to avoid the possibility of such a recurrence. It was true that the gas companies, in having been given the monopoly of putting pipes through London, had taken French license, and occupied the whole of the soil. Some say in consequence of the wood pavements, gas which used to escape to poison the air of London, was now kept underground. Whatever might be the reason or cause, he would give everybody credit, and the gas companies had on all occasions met them very fairly. Before very long there would be Board of Trade rules, or some kind of a report, which would put them right in the future. As to whether or not insulating material could cause explosion, that had been most effectively disposed of by the explosions in boxes where bare copper strip was used. With regard to the contracts for the lesser streets, there were certain sums set aside, and as soon as the City authorities made up their minds it would be their business to light them. They would receive £10 per annum for glow lamps taking 200 watts, and £5 for lamps taking 100 watts, the number being 887. After referring to the system of allowing discounts, the resolution was put to the meeting, and carried.

The Chairman then proposed, and Mr. Edward Lucas seconded, that the following dividends for the half-year ended December 31st, 1894, be and are hereby declared:—On the company's preference shares the sum of 6s. per share, making, with the interim dividend of 6s. per share paid on July 19th, 1894, the full dividend of 6 per cent, per annum for the year. On the company's ordinary shares the sum of 5s. per share. That the respective dividends be paid on February 28th, 1895. This was adopted.

The retiring directors, Mr. Lucas and Col. Ben Hay Martindale, and auditors, were then re-elected.

The Chairman then proposed, and F. W. Reynolds seconded, that the directors be and are hereby authorised to issue the remaining £100,000 of the company's debenture stock, subject to the terms and conditions of the deed of trust dated February 26th, 1894.

This was carried, and a vote of thanks was accorded to the chairman and board of directors and to the staff for their services during the past year.

Telegraph Construction and Maintenance Company, Limited.

The report of the directors, submitted at the thirty-first ordinary meeting held on Tuesday, states that the directors deeply regret to announce the death, on November 12th, 1894, of Mr. Philip Rawson, who had been a much valued member of the board for a period extending over 26 years. The accounts for the year show a net profit of £91,921 7s. 9d., after charging the interest on the debentures. To this sum must be added £51,228 10s. 8d. brought forward from last year, making a total of £143,149 18s. 5d. From this amount is deducted the interim dividend of 5 per cent., paid July 24th, 1894, amounting to £22,410, leaving £120,739 18s. 5d. to be dealt with. Of this sum the directors proposed to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent, free of income tax, leaving £53,509 18s. 5d. to be carried forward to the next account. The operations carried out during the year comprise the laying of a cable for the Eastern Extension Telegraph Company between Singapore, Labuan and Hong Kong, and the manufacture of a cable for the Anglo-American Telegraph Company, and its laying between Valencia and Newfoundland; several lengths of cables have also been manufactured for different telegraph administrations and companies. Repairs of cables have been carried out in the North Sea and English Channel for the German Government. The factories at East Greenwich and Wharf Road, and the company's steamships are in good and efficient condition. The directors have the pleasure to announce that they have elected Admiral Sir Anthony Hiley Hoskins, G.C.B., to a seat at the board.

The meeting of the company was held on Tuesday last at the offices, No. 38, Old Broad Street, under the presidency of Admiral Sir George H. Richards.

Mr. E. Dickens (the secretary) read the notice convening the meeting, and the report and accounts were taken as read.

The Chairman, said that his first duty was to report the death of one of their oldest directors, Mr. Philip Rawson. Mr. Rawson had been connected with the company for 25 years. It was essential, they all thought, to have on their board men who might be said to have a world-wide reputation and influence. They had placed on their board two gentlemen who fulfilled all those conditions in the very highest degree—Admiral Sir A. H. Hoskins and Sir Robert G. W. Herbert. With regard to the business before the meeting, he might fairly congratulate them upon the result of last year's work. They had carried out two rather large operations last year. They had laid a cable for the Eastern Extension Telegraph Company between Singapore, Labuan, and Hong-Kong. That cable was over 1,700 miles in length. It was all laid in the early part of the year; of course, the manufacture of it came into the accounts of the year before. After that they had laid a cable for the Anglo-American Telegraph Company across the Atlantic, between Valentia and Newfoundland. That cable was something under 2,000 miles in length. He believed it was a cable of the largest capacity that had ever been made. However, both those works were carried out with great success, and they were crowded into one half of the year. They could not command the times and seasons, but all their resources were taxed, and the skill and ability of their staff were called into action about this work. And he thought he might congratulate them on the work having been done so well and without any hitch. Since then they had laid some smaller lengths of cable for various foreign governments and companies, and on the whole they had been thereby enabled to pay a dividend of £2 8s. per share, including the interim dividend paid in July. The meeting might perhaps wish to know about the prospects of the present year. They had no contracts in hand, and they met this year with really less work in progress than for some time before. He thought it right to tell them that squarely, but at the same time it not unfrequently happened that all their work came into a half of the year as it did last year; and as the year was early, they hoped of course they would get better business. At all events, they might depend upon it that all the exertions of the company and of the executive would be devoted to that end. Their principal work at present was manufacturing certain lengths of store cable ready for work, and taking advantage of the lull, which had occurred on previous occasions, to put their machinery and appliances in such a state that it would enable them to do their work more efficiently and economically in the future. At the same time, he could tell them that they had the most perfect confidence in the soundness and the healthy state of the company, and he hoped the shareholders would take that as the view of the board. He concluded by moving as follows:—"Resolved that the report and accounts of the directors to December 31st, 1894, submitted to this meeting be and the same are hereby received and adopted, and that a dividend

of 36s. per share, in addition to the 12s. per share interim dividend paid on June 13th, 1894, be paid upon all shares of the company for the year ending December 31st, 1894, and that such dividend be paid free of income-tax."

Mr. GEORGE W. CAMPBELL seconded the motion.

Mr. CROFT said as there had been an article in the *Times* with reference to the question of a Pacific cable, and as that article, speaking of the subject of tenders, had said that one had come from an old-established and reliable firm, he should like to know whether he was right or wrong in assuming that the "old-established and reliable firm" related to their company.

The CHAIRMAN replied that probably they knew a Pacific cable had been written about for years, and all he could really say about it was that it would come some day, but that for the present he thought it was in the air. There had been some seven or eight routes proposed for a Pacific cable to go 7,000 or 8,000 miles, and to do all kinds of things, but none of those routes had been examined, and no specification had been given for the cables—in fact, it was all of the very vaguest kind. No doubt tenders had been asked for, and so far as they could be given they had done the same as others. They had done the best they could, but they could give nothing at all accurately. One company, he believed, had tendered, but if they advertised for a cable to go to the moon, they would have tenders for it, but then contractors were not absolutely bound in such cases. Before a man could give a real tender he must have real questions before him, routes examined, and specifications must be given for the cable. But they might be sure of this, that they were not the "old established reliable firm" spoken of in the *Times*, although they were the oldest company existing that did such work. Whatever difficulties there might be, they might depend upon it the board of this company would not shrink from any of them, and he had no doubt when the time came for the cable to be laid, their company would stand as good a chance as any other. Nothing would be wanting on their part at all events.

The motion having been unanimously agreed to, the retiring director, Mr. G. W. Campbell, was re-elected, as were the retiring auditors, Messrs. J. Gane and P. A. Glegg.

The usual thanks to the chairman and board concluded the proceedings.

Notting Hill Electric Lighting Company.

PROF. CROOKES presided at the ordinary general meeting of this company, held at Bulmer Place, Notting Hill Gate, on Tuesday last.

The SECRETARY (Mr. R. G. Rawkins) having read the notice convening the meeting,

The CHAIRMAN said: It gives me great pleasure to have this opportunity of congratulating you on the continued success of our company. Although we are not making quite such rapid strides as are some of the electric lighting companies, there is satisfaction in knowing that our progress, though slow, is certainly sure.

THE YEAR'S ACCOUNTS.

I think it will be best for me to follow my usual plan of going through the accounts which have been put before you for confirmation. No. 1 Account.—The only alteration in this account since last year is that the issue of preference shares has increased by 441. Since the end of the year, however, a further 450 of these shares have been allotted, leaving the unissued share capital at the present time at £12,610. No. 2 Account.—This account shows that we have not yet commenced to exercise our powers of borrowing, which extend to £50,000 No. 3 (Capital) Account.—The amount spent on this account during the year amounted to £5,032 1s. 5d., but notwithstanding this fact the total expenditure shown is £193 3s. 9d. less than that which appeared in the previous year's account. The explanation is that the sum of £5,205 5s. 4d. in former accounts, representing the cost of opposing injunctions, compensations, general administration, and management expenses during construction and preliminary expenses to the first general allotment of shares, has been transferred, under the advice of the Auditor to the Board of Trade, to a suspense account, and as it is not represented by any visible assets, it will be gradually written off out of revenue. No. 4 (Revenue) Account.—I think you will agree with me that this account must be considered highly satisfactory. There has been an increase in the revenue of £793 7s. 11d., and although this has naturally entailed increased work, the expenses for the same period, as mentioned in the directors' report, have decreased by £127 2s. 8d. The staff deserve our best thanks for the manner they have carried out their duties in order to bring about this result. The working expenses have been now cut down to almost the lowest possible point, but the company has an efficient and hard working staff, and I think I may confidently assert that the business is now being worked on more economical lines than any similar undertaking in London. The gross profit has risen from £1,481 to £2,401, showing an increase of nearly 70 per cent. This, of course, is brought about principally by the additional number of lamps connected; these have increased to the extent of 3,500 during the year, or more than 800 above the additions for the previous year, being, in fact, a larger increase than during any 12 months since the commencement. As a large part of the additional lamps were connected towards the close of the year 1894, we shall only receive the full benefit of them during the current year. The amount of bad debts for the year was only £5 16s. 6d.; this shows the wisdom of our policy in requiring deposits in doubtful cases. The Electrical Association, which was originally formed by the London companies with the view of taking up any important question seriously affecting the industry, has, I regret to say, been dissolved, and the £43 odd appearing in the revenue account, represents the company's proportion of the surplus assets. No. 5 (Net Revenue) Account.—This account requires little explanation from me. The account shows an available profit of £1,543 14s. 7d., which is reduced to £1,243 14s. 7d., after providing for the £300 the directors propose to take for their services during the year, instead of the £1,000 to which they are entitled. I should like to take this opportunity of stating that the directors have now surrendered fees amounting altogether to £2,510. I have a resolution to propose presently dealing with the balance of undivided profit; but before dismissing this account, it may be well to mention that nearly £1,300 have been taken out of the year's revenue for repairs and depreciation, or 25 per cent. of the gross receipts. No. 6 (Depreciation) Account, and No. 7, General Balance-sheet.—These speak for themselves, and I do not think there is anything in either of them requiring comment. The certificate of the auditors appears at the end of pages 8 and 9. In addition to this I may mention that as they carry out their work every three months, they also supply the board with a quarterly report on the accounts. I regret to say that our lamp earnings are still very low, reaching only to about 6s. for each 8-C.P. lamp. This is much lower than any of the other London companies, and you will readily understand that very few customers have earned a discount, the lowest rate of 5 per cent. being allowed only when the earnings per lamp for the year reach 10s. Considering the smallness of the company's output, the sheer cost per unit reflects the greatest credit on the engineering staff, and it will compare favourably with other London companies, some of which are sending out nearly 20 times our number of units.

EXTENSIONS.

Towards the end of the year an important extension of the mains was made from the Phillimore district, along Kensington Road, throughout Melbury Road, and a part of Addison Road. This work was carried out entirely by our own staff, thereby effecting a considerable saving in the expense. I am pleased to say that although the extension cost about £3,400, it is already more than paying its way, besides satisfying several of the residents in the Melbury Road district, who have been anxious to have the light for a long time past. Other small extensions have been made during the year to connect up houses requiring the light, and in every case a satisfactory return on the capital outlay has been obtained. The total capital spent on new mains during the year was £4,083 4s. 7d. You will have learnt from the directors' report that they have applied for powers to light the area adjoining the present one on the northern side, including Uxbridge Road, Ladbroke Grove, and many other streets of more or less importance. The Board of Trade has approved the draft provisional order, and the only thing now required is for Parliament to pass the Bill confirming the order. The only streets in which the company undertakes to lay mains within two years from the date of the order are Archer Street, Ladbroke Gardens, Norland Square, and parts of Uxbridge Road, Ladbroke Grove, and Portobello Road. Before agreeing to this, the directors took the precaution of having these streets canvassed, and from the results obtained we felt justified in agreeing to this compulsory area. When these powers are obtained, we shall have greater facilities for supplying current in the Western or Addison Road district of our present area, where we have not yet been able to send current, except to the Melbury Road end, owing mainly to the difficulty of obtaining the necessary site for a battery station, and to the fact that Uxbridge Road, our only available approach to Addison Road on the north, is outside our present area. This was one of the chief reasons we had for applying for additional powers, and directly our new order comes into force we propose constructing a main down the Uxbridge Road, continuing it along the Addison Road, and so connect it with the mains recently laid in that neighbourhood. By this means we hope to supply a large number of lights without going to the expense of erecting a battery station.

EXPLOSIONS.

It is a matter for regret that explosions of gas have recently taken place in electric lighting main culverts, but so far we are to be congratulated on nothing of the kind having occurred in our district. The directors hope shortly to have all their culverts ventilated, thereby preventing, as far as possible, any accumulation of gas in them, and a plan for carrying this out is now having full consideration. No accident of any kind has occurred, and although the winter has been exceptionally severe, everything has progressed satisfactorily, with the exception of a little water recently getting into our culverts through the bursting of a water pipe. No stoppage whatever has occurred in the supply of current throughout the year; in fact, I believe the only stoppage we ever had was the one which occurred a year or two ago when the current was turned off for two hours in the early morning. With this exception current has been supplied to our customers day and night uninterruptedly since it was first switched on on May 30th, 1891. In conclusion, I should like to say that the directors' first consideration has been to give a return to the holders of the ordinary share capital, and everything that could properly be done to bring about this result has been done. Although the dividend is not so large as could be wished, now that the dividend earning point has been reached, there is every reason to believe that it will go on increasing, and the future increased prosperity of the company seems to me fully assured. I now beg formally to propose:—(1) That the report of the directors and the accounts to December 31st, 1894, submitted to this meeting, be, and the same are hereby approved and adopted. (2) That a dividend at the rate of 6 per cent. per annum for the half-year to December 31st, 1894, be, and is hereby declared on the ordinary preference shares payable forthwith, making with the interim dividend paid in July, 6 per cent. for the year. (3) That a dividend of 2s. per share, free of income tax, be, and is hereby declared on the ordinary shares of the company, payable forthwith. Perhaps one of my co-directors will second these resolutions, and I will put them to the meeting *seriatim*, unless any shareholder would like to make any remarks before I do so.

Mr. Alexander Howden seconded, and no questions being asked, the report was adopted.

Mr. Burners proposed the re-election of the retiring directors, Col. Buttanshaw seconded, and the resolution was adopted.

Mr. Bradford proposed the re-election of the auditors. This was carried, and the proceedings terminated.

Kensington and Knightsbridge Electric Lighting Company, Limited.

The eighth ordinary general meeting of the Kensington and Knightsbridge Electric Lighting Company was held at No. 1, Great George Street, Westminster, on Thursday evening, February 21st, Mr. Granville R. Ryder presiding.

Mr. R. S. Erskine (secretary) read the report of the directors.

The Chairman said that they would have probably observed from the newspapers that last week they had a very serious fire at Kensington, and doubtless it would interest them to have some details of that before he went into the general transactions of the company during the past year. The fire took place a few minutes after 10 on Tuesday night. It broke out on the floor above the machinery and engine room, which was fortunately a concrete floor. The damage done was very considerable. The whole of the batteries were destroyed, and a great many valuable instruments, and also the floor above, in which lived the foreman, his wife and three children. The estimated actual damage done seemed to be between £5,000 and £6,000, which fortunately was covered by insurance. Mr. Crompton, their chief engineer, and Mr. Miller, were fortunately on the spot within a very short time of the fire breaking out, and owing to their energy and rapidity not only was the fire got under in a very short time, but also they managed to prevent there being any breach of continuity of the electric current for more than three hours, which was a wonderful fact considering the damage done in the place. The most unfortunate occurrence was that one of the children of the foreman was suffocated. Since then an inquest had been held, and a verdict of accidental death was returned, but at the same time a rider was added that the fire was not caused by any process connected with the manufacture of electricity, various rumours having been circulated that experiments were being tried and had caused the fire. They hoped in the course of three or four months the whole of their plant would be reinstated, and that they would return to the state of efficiency they were in before the fire. Their thanks were specially due to Mr. Crompton and Mr. Miller for their energy on the occasion by which they prevented what was a serious fire from being at least a disastrous one. The continuity was restored at 1.30. It was a curious fact that there was a greater loss of light on the negative side than on the positive side of the system, but in no case was there more than three hours lapse of light.

Sir Arthur Clay remarked that the light never went completely out.

The Chairman said he expected Sir Arthur Clay was on the positive side. In the capital account there was an increase of £5,040 in the 5 per cent. second preference shares, and £8,000 in the 4½ per cent. mortgage debentures, making a total of £13,040. Of that they had about £1,500 in hand at the present time, and the rest had been expended in plant, mains, &c. In the revenue account the sale of electricity had gone up to 977,797 units which was against 724,308 in the previous year, a gain on the year of 253,489 units. At the same time there was a net profit on the year over that of the previous year of £4,000. Last year the amount was £20,746, and that year it was £24,738. That showed they had been able to increase the output and sale of electricity by nearly one-third at an additional cost of only one-fifth, or that they had been able to earn £4,000 at an outlay of about £1,000. Those were satisfactory figures, and were a great credit to their working staff. Then, on the other side of the account, he should say a word about the amount they had written off, which was no doubt rather a large sum. As regarded preliminary expenses (£500), they felt that that was a thing which should be paid off as soon as possible; and as regarded the £1,199 (suspense account), that really belonged to the credit side of the capital account, but they thought as they were in a position, it was better to pay these sums, especially as the concern was paying a fair dividend to the shareholders. As regarded the third item of £3,457 placed to the renewal account, they thought it very important to be able to consolidate that account. Their business was founded on a highly progressive science, that of electricity, which, perhaps, although not in its infancy, had not reached mature age, and it was important to have a fund to fall back upon for renewals and the acquisition of the latest improvements. The price of electricity to consumers had been reduced 25 per cent. during the year, that reduction taking place from July 31st. A shareholder the other day met him in the street and said they did a Quixotic thing in reducing their rates when they were not compelled to do so. He did not see that, as all the grace of the thing was gone if they did not do it until they were actually forced. Besides that, he did not think they could hold out, inasmuch as other districts adjoining, besides the Westminster and St. James's Park Company, reduced their rates to customers. They had some grumblings with regard to the rates, and they felt to cheapen the product would increase the demand, and they knew very well the more electricity they made the cheaper they could do it. Of course, they had not much opportunity at present of testing the results, for they only had that half-year to show them; but, as far as that went, they could fairly say it was successful. The increase, as he said before, was 253,489 units, of which 100,000 belongs to the first half of the year, and 153,000 to the second; that showed an increase of one-third on the second half. There was one other matter he would touch on. They would remember that last year they got powers to purchase a small district belonging to the Chelsea Company, and he thought it would be interesting to them to know how the purchase turned out. The amount they paid to the Chelsea Company was £7,000; they had spent about £2,000 on mains, and legal and other expenses brought the whole cost up to about £10,000. On that £10,000 they had made a gross income during the year of £1,777, and a net income of between £800 and £900. The money by which that was done was procured by debentures at 4½ per cent. Therefore the result was that they earned £900 at a cost of about £450; and that was, he thought, a satisfactory result. There were no other points to which he need call their attention, and he begged to move that the report and accounts be adopted.

Sir Frederick Bramwell, Bart., seconded the motion, and said, as a shareholder, he was gratified with the results.

Mr. Parker Young thought the fixed charges might have been spread over two years, which would have enabled them to pay a 6 per cent. dividend. As to the debentures, he thought the time had arrived when they would be taken up at 4 per cent.

The Chairman said that with regard to the issue of debentures at 4 per cent., a committee was considering that particular point.

A motion for the declaration of a dividend of 5 per cent. was then carried, and Sir Frederick Bramwell and Mr. G. H. Hopkinson were re-elected directors.

On the motion for the re-election of Messrs. Lovelock, Whiffin and Dickinson as auditors, Mr. Wallace explained that action was being taken to try to save the expense of a double audit by the other companies, and in case anything was done, it would be desirable that they should join with them.

Mr. Young then moved that the following words be added to the motion for the election of auditors: "And that the Board of Trade be approached, with the view to the expense of a double audit being saved."

This was seconded by Sir Arthur Clay, and carried.

Sir Arthur Clay said that there was no provision made in the accounts for directors' remuneration. From what he could see of the condition of the company and its prospects, the directors must have given a great deal of care and attention to it, and he was sure the shareholders would concur in giving the directors proper remuneration, and therefore he had great pleasure in proposing that the sum of £500 be paid to the directors for their services.

This was seconded by Mr. Young and carried.

A vote of thanks to the chairman concluded the business.

Official Notices re Limited Companies.—The *London Gazette* has contained notices to the following effect from the Registrar of Joint Stock Companies:—Struck off the register, and another company formed instead, St. Luke, Chelsea, Electric Lighting Company, Limited. To be struck off within three months, unless reason is shown to the contrary: Albert Hoster, Baily & Grundy, Bishop's Stortford Electric Light and Steam Laundry Company, British Electrolytic Syndicate, Cambridge University and Town Electric Lighting Company, Carbon Electric, Clegg's Metal Incandescent Lamp Company of France, Croydon Electric Supply Company, Devonshire Electric Light and Power Supply Company, East Coast Electric Light and Power Supply, Electrical Inventions Company, Electrical Standardising, Testing and Training Institution, Electricity and Electrical Engineering Newspaper Company, Electric Stores, Ipswich Electricity Supply, Islington and General Electric Supply, Lane-Fox Electrical Company, London Electrical Tramways Company, Nonpareil Electric Syndicate, Paddington and Bayswater Electric Light and Power Supply Company, Pontypridd Electric Lighting Company, Provincial Electric Light and Power Supply Company, Putney and Hammersmith Electric Light and Power Supply Company, Woking Electric Supply Company.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, February 27th, a special settling day in City of London Electric Lighting Company, Limited, provisional scrip certificates of a further issue of £200,000 5 per cent. debenture stock, and have ordered the same securities to be quoted in the Official List.

Swan's Electric Light Company, Limited.—A general meeting of above company will be held at 141, Pilgrim Street, Newcastle-upon-Tyne, on Saturday, March 23rd, 1895, at 10 a.m., for the purpose of having laid before the meeting the account of the liquidator, showing the manner in which the winding up has been conducted, &c.

The City of London Electric Lighting Company, Limited.—The warrants for the dividends on the preference and ordinary shares of the company have been posted.

Edison & Swan United Company.—A meeting to confirm resolutions, published in recent issues of the Review, was held yesterday.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 24th, 1895, amounted to £949; week ending February 25th, 1894, £945; increase, £4; total receipts for half-year, 1895, £7,988; corresponding period, 1894, £7,610; increase, £378.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending February 24th, 1895, amounted to £847; corresponding week last year, £616.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 22nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,230.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation February 20th.	Closing Quotation, February 27th.	Business done during week ended February 27th, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg , Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	..
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	40 — 41	40 — 41	41	40¾
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	75½— 76½	75½— 76½	76½	76
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	6¼— 6⅝	6¼— 6⅝	6 9/16	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	11¾— 12¼	11¾— 12¼	12¼	11⅞
75,000*l*	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	109 —113	109 —113	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	3½	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14 xd	13 — 14	13⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21 xd	20 — 21	20¼	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½— 10	9½— 10	9⅝	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	8½— 9	8½— 9	8⅞	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16½— 16½	16½— 16½	16½	16½
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17½— 18	17½— 18	...	...
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	..	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	4 %	4 %	..	124 —127	124 —127	126	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17¼— 17½	17⅛— 17⅜	17 5/16	17
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	103 —107	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	104 —107	104 —107	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	123 —126	123 —126	...	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	103 —107	103 —107	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	...	104 —107	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	...	106 —109	106 —109	107⅜	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115	112 —115	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	...	9⅜— 9⅞	9⅜— 9⅞	9⅞	9 11/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅜— 16⅞	16⅜— 16⅞	16⅞	16 11/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	22 — 22½	22 — 22½	22⅜	...
190,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	106 —109	106 —109	106¾	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 55	53 — 55	54	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	...	5 — 7	5 — 7	...	.
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	.	105 —109	105 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000 ...	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	6 %	6 %	...	1½— 2½	1½— 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5½— ⅜	5½— 5⅝	5⅝	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15 — 16	15½— 16½	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15 — 16	15 — 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	6 — 6¼	6 — 6¼	6 3/16	6 1/16
1,100,000*l*	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 —106	104 — 106	106	104⅝
48,800	New Teleph., Ltd., 25,901 to 74,700 ; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec , Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	9/16 — 11/16	9/16— 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	3 — 4	3½— 4½	4⅜	...
3,381	Submarine Cables Trust	Cert.	...	...	...	118 —123	118 —123	120	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	86 — 91	86 — 91	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2⅛	1½— 2⅛	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3½%	10½— 10⅝	10 — 10⅛	...	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	5 %	5 %	5 %	6¼— 6⅝	6¼— 6⅝	6⅛	6⅜
33,129	Do. do. do. 5 % Def.	7½	...	...	...	4¼— 4⅝	4 — 4⅛	...	...
171,900*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	101 —105	101 —105	...	...
214,800*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅜%	⅛%	1 — 1½	1 — 1½	1⅛	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	10⅜— 11¼	10⅜— 11¼	11 3/16	11
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	9⅛	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	115 —120	...	...
166,900*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	104 —106	104 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5 — 5⅛	5 — 5⅛	5⅛	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	2½%	13½— 14½	13½— 14½	13⅞	13¾
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15¼— 15¾	15½— 15¾	15⅝	...
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	136	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅛— 7½	7¼— 7⅜	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	...	9¾— 10¼	9¾— 10¼	10⅛	10
100,000*l*	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	118 —120	118 —120	120	118
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7 — 7½	7 — 7½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	7½— 8 xd	7½— 8	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9 xd	8½— 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7½— 8	7½— 8	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Feb. 20th.	Closing Quotation, Feb. 27th.	Business done during week ended Feb. 27th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅝ — 2⅞	2⅝ — 2⅞	2⅞	2 11/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2⅜ — 2⅝	2⅜ — 2⅝	2⅝	2½
125,000/	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	115 —118	115 —118	117	...
630,000/	City and South London Railway	Stock	⅝%	⅝%	1¼%	46 — 48	46 — 48	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	3 — 3½	3 — 3½	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	...	102 —107	102 —107	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	¼ — ½	¼ — ½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1¼ — 1⅝	1¼ — 1⅝	1½	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1½	1 7/16	1¼
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	...	9½ — 10½	10 — 11	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	23 — 24	23½ — 24½	24	23½
200,000/	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8 9/16 — 8 11/16 xd	8 9/16 — 8 11/16	8⅝	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	13 — 13¼ xd	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	45 — 47	46	45⅛
150,000/	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2⅜ — 2⅝	2¼ — 2⅜	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), 1¼—2
House-to-House Company (£5 paid), 3⅞—4.
Do. do. 7 % Preference, of £5, 7¼—⅞.
Do. do. 6 % Debentures of £100, 107—109.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7¼—7⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7¼—7½.
London Electric Supply Corporation, £5 Ordinary, 7s.—10s.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 98—102.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—5⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Reversible Regenerative Armatures and Short Air Space Dynamos. By W. B. Sayers, Associate. Read Thursday, February 14th, 1895.

The subject of the present paper is the development of the commutating device for continuous current dynamos, which I had the honour of bringing under your notice two years ago, and which has since been put into practice to a considerable extent by Messrs. Mavor and Coulson, of Glasgow, and other firms.

It will be remembered that in my former paper I described a machine, the armature of which generated its own field, the usual field magnets being replaced by simple ⊏ -shaped iron blocks, which Lord Kelvin, on viewing the machine, at once appropriately called "keepers." This property of a generator armature, when commutated on the backward lead, of producing or augmenting, as the case may be, the effective magnetic flux may, I think, be correctly described as a regenerative property, and I therefore propose to call armatures capable of being so commutated "regenerative armatures."

I may here state what are the advantages secured by the use of the devices about to be described.

1. The commutation of slotted or tunnel armatures, which it is generally admitted are very desirable from a mechanical point of view, but the iron embedded coils of which, necessarily, have a high coefficient of self-induction, is successfully performed, and that with the shortest permissible air space and minimum exciting power in the field.

2. Not only may such armatures be successfully commutated, but speaking of generators they may be commutated on the backward lead, and when this is done the magnetic circuit may be the shortest possible (and consequently the lightest possible) while still allowing sufficient space for shunt winding, the forward turns on the armature securing an approximately level, or even, when desired, a rising characteristic, the shunt only requiring to be sufficient to give the initial field required for the light load E.M.F.

3. It is found practicable to commutate very heavy currents without having resort to duplex or triplex winding and consequent many part commutators, or of going to four or more poles for large machines; and this coupled with the fact that the iron embedded conductors do not require to be laminated, renders large armatures on my plan not more, but rather less expensive to build than the older types, thus doing away with the main objection which has been raised to the use of commutator coils, *i.e.*, that the cost of the armature is increased by their use. As an example, a machine will be found described later on having only 36 parts in commutator; main conductors of solid bar almost lightest possible magnetic circuit, the output being 800 ampères and 100 volts at 420 revolutions per minute; the combined efficiency of engine and dynamo being 87 per cent.

Reversible Regenerative Armatures.

It was found that in many cases it was a serious drawback to machines constructed with regenerative armatures on my plan that they could only be run in one direction; in other words, the device was not reversible without structural alterations in the armature. I found a solution to this difficulty, however, in the construction shown in figs. 1 and 2. In these figures, A^1 and A^2 represent two sections of

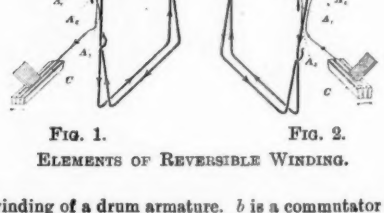


Fig. 1. Fig. 2.

Elements of Reversible Winding.

the main winding of a drum armature. *b* is a commutator coil, which is connected to the main winding at the junction, A^3, between coils, A^1 and A^2. C is a commutator segment. The direction of winding is the same in the two figures, but in fig. 1 the direction of rotation is represented as being clockwise, while in fig. 2 it is counter-clockwise. A little study of these two diagrams will show that the commutator coil acts in precisely the same way in whichever direction the armature rotates, the brushes being always set with a backward lead, so as to bring the side of the commutator coil, B^1, or B^2, as the case may be, which is behind the point of connection (A^3) to the main winding under the edge of the flux horn. It will be noticed that in both cases only one side of the commutator coil, *b*, is operative, the other side being in a position in the interpolar gap, where normally there is no effective field.

I do not propose on this occasion to take up time with a minute

description of the action of this device, the action of the reversible form now described being substantially the same as the simple form described in my earlier paper. In a few words, however, I may say the effective part of the commutator coil is still well under the flux horn when the commutator bar to which it is connected comes into contact with the heel of the brush, while the commutator coil immediately preceding it, which is under the brush, and momentarily carrying the full current, is just passing out of the field, and consequently is the seat of a weaker and rapidly falling E.M.F.; the result of which is that the current flowing from the main winding is rapidly transferred to the more backward coil, which is still in the strong part of the field, and so is the seat of maximum E.M.F. In this way a third commutator bar comes under the heel of the brush, the action already described is repeated, and so the commutation proceeds. (See fig. 9.)

I do not know whether it has been generally noticed that a close analogy exists between the problem of sparkless commutation and the problem of preventing knocking in a high-speed engine. In the latter case the valve must have a certain amount of lap and lead in order to give a sufficient compression, and put on the live pressure at the proper time, to just bring to a stand the motion of the connecting rod, piston, &c., at the moment the crank is on the dead centre, and to restart them in the opposite direction. Just as the inertia of the reciprocating parts of the engine must be overcome by the steam pressure, and not by the crank action, so the reversal of the current direction of the armature sections against the self-induction (the electrical analogue of inertia) must be overcome by internal electromotive forces, and on no account by the make-and-break action of the commutator plates and brushes. I think the analogy between these two things is strikingly complete.

Auxiliary Devices.

In the simplest form of reversible machine only half the length of the commutator coil is effective in producing the reversal when the armature is running in a given direction. Fig. 3, however, shows a

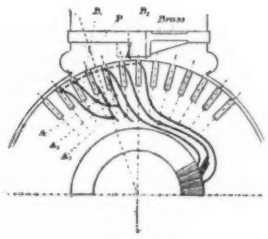


Fig. 3.

means of bringing both sides of each coil into operation. P is a pole piece forming an extension of the flux horn, leaving a recess having an angular breadth approximately equal to, or a little greater than, the angular width of each commutator coil. The commutation is effected in this recess, the section of main winding being located about midway in this recess at the time when the current in it is changing. It will be seen that the same action as has already been described, takes place with regard to the part of the commutator coil which is behind the plane of commutation; but, in addition to this, the forward part of the coil next in front—in which the current is falling—has come under the polar extension, and as the field under this extension is of the same direction as under the main portion of the polar surface, while the coil is cutting it in an opposite sense, this coil is the seat of a back E.M.F., which operates against the current in this coil, and so assists in producing the reversal of the main armature section, which is in series between the two commutator coils under consideration.

In fig. 3 it will be noticed that the polar extension, P, is shown in full, spanning four teeth; that is, one tooth more than the number embraced by a commutator coil. Using Dr. Thompson's notation, the breadth of a commutator coil is 3β. Dr. Thomson uses β to signify the angular breadth of a section of armature winding or of a segment of commutator, and according to what I have said in the paper as printed this should be the angular breadth of the space spanned by the polar extension, P. Since writing this paper, however, I have found it to be a great improvement to make the polar extension, P, span $= 3 - 1\beta$, or $2{\cdot}5 - 1\beta$, according to the nature of the winding.

The advantages secured when the polar extension, P, spans this additional extent of the armature, are: 1. The whole armature current is never carried by one commutator coil as it is for part of the time in the former construction, but is divided between two and between three alternately; as a consequence the maximum value reached by the current is only about half as great compared to the value reached when the polar extension has the shorter span, and, moreover, the period occupied by the rise and fall may be as much as double, so that the time rate of change of the current, both in commutator coils and also, of course, in the section of main winding undergoing commutation is greatly reduced. The opposing E.M.F. of self-induction is, of course, correspondingly reduced, so that a much heavier current may be sparklessly commutated when the polar extension is made to span the greater breadth.

2. When the span of the polar extension is equal to the angular width of a commutator coil, the bearing surface of the brush must not be greater than the width of one commutator segment, but when it is made to span the greater width, the brushes may cover anything between one or two segments, so that the length of commutator may be reduced without diminishing the area of surface in contact between the commutator and brushes.

In designing machines with a polar extension such as I have described, it must be borne in mind that, as the flux conveyed by the extension, P, enters the armature at a point past the plane of commutation, it is non-effective in generating E.M.F. as it enters and leaves the armature on the same side of the plane of commutation; it must therefore be treated as leakage, and provision made for this non-effective flux in the cross section of the field magnets.

Number of Segments in Commutator.

The necessity hitherto found for using a large number of sections in the commutator, and of resorting to duplex or triplex winding in the case of large low tension machines, ceases to exist when machines are designed on the lines I am describing, and the number of segments is governed practically by the difference of potential, it is advisable to allow between adjacent commutator plates. Of course, it would generally be inadvisable to reduce this number sufficiently to make the current undulatory to an appreciable extent, unless for machines for arc lighting.

That nothing is gained by using a large number of sections in the commutator is easily found from theoretical considerations, and is borne out by experience. Consider a two-pole drum armature having 24 coils in series generating the E.M.F.—that is, a total of 48 coils. If we use a 48-part commutator, the time occupied in the reversal of an armature section will be one forty-eighth of the time of one revolution. If, however, we use a 24-part commutator, the time occupied will be one twenty-fourth. The reversing E.M.F. will therefore be acting for twice the time in the latter case, as compared with the former. In addition to this, in the latter case the angular distance between successive commutator coils is doubled, so that the one which is going out of circuit is farther away from the pole tip, and so well out of the fringe; so that the reversing E.M.F. (which is always the difference between that generated in the coil going out of circuit and the coil coming into circuit under the brush) is greater with the lesser number of segments. And, again, whereas in the first case the opposing self-induction is that of one main section plus two commutator coils, in the second it is only two main sections plus *two* commutator coils—that is, less than double; and then, most important of all, the rate of change is only one-half in the latter case of what it would be in the former. The reduction of the number of bars in the commutator has the further advantage that it allows of the brushes bearing on a larger arc of the commutator surface, so that a smaller width of brush is necessary. It would not do, however, to reduce the number of slots, or tunnels, in the armature, and put two coils in each instead of one, as this would have the effect of increasing the self-induction four times.

Design of Slotted, or Tunnel, Armatures.

Just as the steam engine designer makes his reciprocating parts as light as possible consistent with strength, so it is worth while to so design the slots, or tunnels, in an armature as to get the least amount of self-induction; and this is, to some extent, antagonistic to other desirable features in short-air-space machines.

In the first place, in order to keep down the self-induction, the opening at the top of the slot should be as wide as possible, consistently with its not exceeding the limit where appreciable loss would occur through eddies in the polar surface of the field magnets. The width of this opening, as stated in my former paper, should not exceed one and a-half times the air space. I usually make it about one and a quarter times. Next, the number of conductors in each slot should be as small as consistent with considerations of cost of manufacture; though, as already shown, it is advantageous in many cases to make the number of commutator blades as small as possible—the conductors in two or more pairs of slots forming but one section of the winding. In figs. 3, 4 and 5, are represented some designs of slots which have given satisfactory results in machines made by Messrs. Mavor and Coulson. In fig. 3 is represented a plain slot with reversible commutator coils, the number of segments in commutator being equal to the number of slots in the armature core. The commutator coil embraces three teeth, or has an angular breadth of 3β. There are thus two commutator coil wires and two main armature conductors in each slot; of the two former, one only is in operation at a time, the second belonging to a commutator coil further back under the pole, and which has not yet come into circuit under the brush. Fig. 4 re-

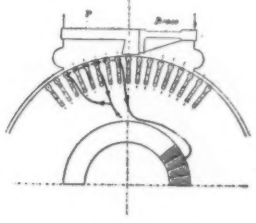


Fig. 4.

presents a slot having a groove planed near the top on each side into which the round wire forming the commutator coil is slid, and the commutator coils half that of the main coils, the commutator coil embraces five teeth, and its angular width is thus $2\frac{1}{2}\ \beta$, there being two convolutions of main winding to each section, but each convolution wound in a pair of separate slots. In this design the number of commutator blades is half that of the slots, and the alternate wires come into operation in succession, the wires intermediate between these belonging to commutator coils further back,

and not in circuit for the time being. This design, in addition to advantages already pointed out, permits of the armature being a little smaller in diameter, and also requires no binding, the commutator coils effectively securing the main conductors in their position in the core. Fig. 10 is a diagrammatic representation of the winding. In fig. 5 is represented a construction adopted in an 80-kilowatt

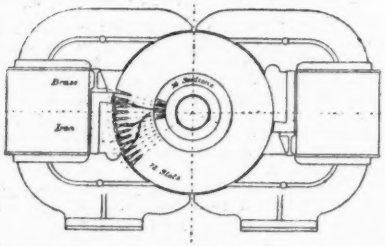


Fig. 5.—80-kw. Dynamo, 400 Revs., Constant, 200.

machine for direct coupling, the speed being 420 revolutions per minute. This machine I shall describe later on. The number of commutator blades is one-half that of the slots, but equal to the total number of convolutions of main winding. Instead of the conductors at opposite potentials—*i.e.*, those connected at the time of commutation to the opposite brushes—being in the same slots as is the case in the other two figures, these are wound in separate slots, each convolution of the winding passing through slots which are one remove from being diametrically opposite. Figs. 11 and 12 represent diagrammatically this winding. The result of this construction is that the self-induction of a main armature section is only about one-half of what it would be if there were two conductors in one slot, both undergoing commutation at the same time.

The quotient of $\frac{\text{Output in watts}}{\text{Revolutions per minute}}$ gives the size of A machine. We have lately at Messrs. Mavor & Coulson's works taken to calling this machine constant.

I find it very convenient in fixing the size of a machine to take as a basis the total flux, N, and this I make proportional to the square root of the machine constant. Having N fixed the areas of all sections of the magnetic circuit are found by dividing N plus the leakage allowance by the value of β, which is desired in each portion of the magnetic circuit. Thus the output of the machine is taken as being proportioned, not to the third power of the lineal dimensions, but to the third power of the square root of the cross sectional area at any given point in the magnetic circuit. Proceeding in this way the preliminary calculations are not hampered by having to take into account the space occupied by the shaft, the depth of teeth, &c.,

$$\text{N} = \frac{\text{Machine constant}}{1} \times 1{,}350{,}000.$$

The current which may be commutated in machines of the type I am describing is given by the empirical formula:

$$i_x = \frac{\text{N}}{l \times \text{x} \times n}.$$

Where i_x = the current per slot in main winding.
N = total flux per pole.
l = length of armature core in centimetres.
n = number of slots.
x = a variable depending for its value on the average co-efficient of self-induction of main winding and commutator coils.

In some 30 kw. machines having a constant of 39·5 the armature cores measuring 34·3 cms. long by 34·3 cms. diameter, the value of x is 17, the form of slot being similar to that shown in fig. 3.

In the 80 kw. machine herein described having a constant of 200 the value of x is 13·5. The fact of this machine working sparklessly with the lower value of x is due to the method of winding and to the larger openings at the top of slots. The value of x depends upon the form of slot, and especially on the width of the opening at the top, and in the disposition of the conductors in them. The co-efficient of self-induction, L, is greater in the main conductors than in the commutator coils owing to these being deeper in the slots and greater also in the lower conductors than in those near the surface for the same reason. I take the self-induction of the end connections as negligible compared with that of the portions of conductor embedded in slots.

This empirical formula is of course capable of being developed into a scientific one by substituting the true value of L for the quantity x, and taking all the particulars of the winding length of air space and other conditions into account. The formula, however, is only independent of the speed at which the machine runs, so long as the resistance of the conductors remain a negligible quantity, which it does throughout a considerable range.

Parallel Running.

It is almost unnecessary to say that machines for running in parallel must not have a rising characteristic—at any rate, when combined with their driving power. I have made no experiment with direct-driven plants; but it is evident that if a combined plant running on the governors gives a falling characteristic, two or more such plants would run parallel, although the dynamo, when driven at absolutely *constant* speed, had a rising characteristic. Of course, the characteristic is under the control of the designer, and apart from questions of permeability of the magnetic system and relative magnetising powers of shunt and armature, depends upon the position of the plane of commutation relatively to the neutral plane.

Take fig. 6, which is the characteristic of an 80-kilowatt machine when driven at a constant speed. This shows a rise up to 300

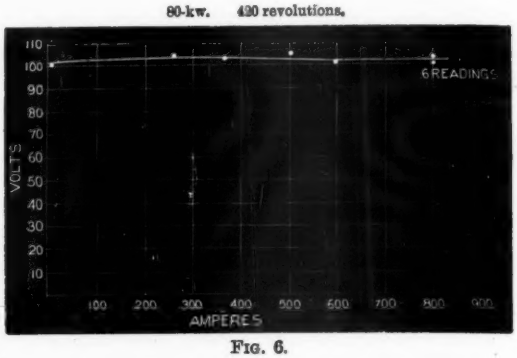


Fig. 6.

ampères, after which there is a gradual fall down to full load. If driven at a rigidly constant speed, or if coupled, or run from the same power supply, so as to both run at the same speed, two such machines would not run in parallel with safety. Fig. 7, however, is the characteristic of the machine and engine combined, when the latter is running in its governors. The increase of speed with light

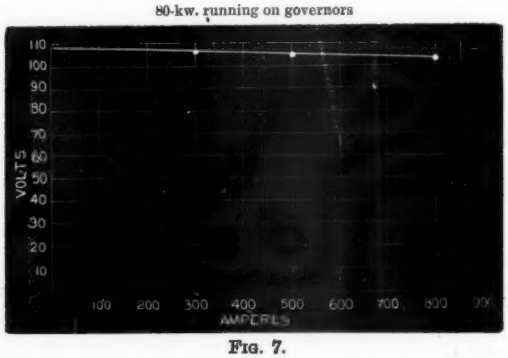
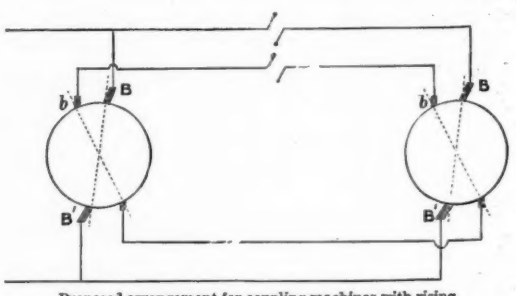


Fig. 7.

loads is sufficient to transform the characteristic into a falling one, from which it results that two such separate plants would run in parallel perfectly. As I have already said, however, there is no difficulty about designing a machine to have a falling characteristic, even if driven at constant speed.



Proposed arrangement for coupling machines with rising characteristics in parallel.

Fig. 8.

So far as my experience goes, there is not much inclination to run compound, by which I mean machines with a rising characteristic, machines parallel in this country; but if it were desired to do so, the arrangement which suggests itself—a modification of the well known method for machines with compound winding—is shown in diagram (fig. 8). The brushes, B, B, are the main ones, set with a backward lead, while b, b, are small subsidiary brushes, set on the forward lead. Suppose one machine were started, and it were desired to connect the second one in parallel, the second machine would be started and its E.M.F. adjusted in the usual way; the small brushes, b, b', on the first machine would then be put down; next the two small, and after that the two sets of main brushes on the second machine. When connection is established between the two armatures at the four points, b', b', and B', B', on the same side of the

commutators, part of the current traversing the coils between the two planes of commutation will leave the first armature by the small brush and flow through similar coils on the second armature, just as the current from the series coils on compound machines splits up between the two series coils when they are first thrown into parallel in the well known arrangement. The other brushes may then be put

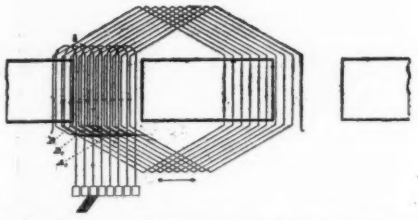


FIG. 9.—DIAGRAM OF WINDING, WITH ONE COMMUTATOR COIL TO EACH TURN OF MAIN WINDING.

down and switches closed, when the small brushes on the forward position will give stability to the system, in the same way as the independent connection to the brushes keeps compound machines from any tendency to play into each other. Although I have not tried this arrangement, I think there is no doubt that it would work satisfactorily if it were desired to run machines with a rising characteristic in parallel. It is usual, however, in central station work in this country to use shunt machines, and to control the current from each machine by means of a variable resistance in the shunt; and no doubt it will generally be preferred to use machines with a slightly falling characteristic for running in parallel, so as to avoid all complications. I may point out that with short air space machines con-

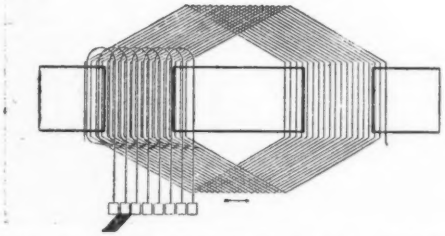


FIG. 10.—DIAGRAM OF WINDING, WITH ONE COMMUTATOR COIL FOR EVERY TWO MAIN CONVOLUTIONS.

siderable regenerative power is required in the armature in order to get even a moderate fall in the characteristic.

ROCKING BRUSH-HOLDERS FOR REVERSING MOTORS.

For reversible motors the fact of the regenerative armature requiring a forward lead instead of a backward one, allows of a very simple and reliable automatic arrangement for shifting the brushes on reversal of direction of rotation. The rocking arm carrying the brush-holders is mounted on the shaft, and suitably bushed and lubricated so as to move freely; the friction of the brushes causes it to be carried round with the armature until brought up by stops which limit its travel in either direction. These stops are, of course, adjusted so as to keep the brushes in the proper position for sparkless

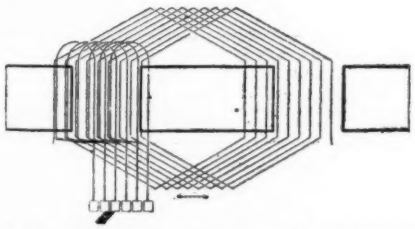


FIG. 11.—DIAGRAM OF WINDING OF 80 KW. DYNAMO.

commutation. Thus the position of the brushes is automatically changed without any sparking, as during the time in which the brushes are travelling from one position to the other immediately after a reversal they do not move relatively to the commutator, but travel round with it until brought up by the stops; so that there is no relative motion of commutator and brushes until the proper position is reached, and consequently no sparking (see fig. 13).

CONSTANT SPEED MOTORS.

The question has been put to me from more than one quarter whether motors fitted with regenerative armatures would be self-regulating—that is, run at constant speed with varying load when supplied with constant pressure at terminals—because the ordinary shunt motor owes its self-regulating qualities to the back turns in the armature, which have the effect of reducing the flux, and so compensating, so far as speed is concerned, for the increased drop of pressure caused by dead resistance in the conductors internal and external to the machine. The reply to this question is, that while in the case of generators it may be inadvisable to reduce the air space below a given value on account of the crowding up of lines due to the large armature reaction, causing a diminution in the total flux, and so bringing down the characteristic, in the case of a motor this action can be taken advantage of and the air space reduced to a safe mechanical clearance: the reduction of the total flux due to crowding up will then tend to compensate for drop of pressure due to dead resistance. So that in the case of a motor we obtain the happy concurrence of lightest weight and minimum cost with best regulating qualities.

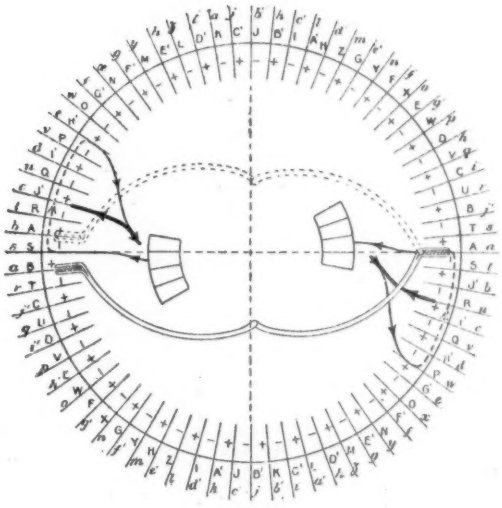


FIG. 12.

DESCRIPTION OF 80-KILOWATT DYNAMO BUILT BY MAVOR AND COULSON—420 REVOLUTIONS PER MINUTE.

Armature.—Diameter over all	...	...	...	21	inches.
„ core ...	...	...	...	17½	„
„ hole in discs	...	...	...	4¼	„

Total flux (effective), N = 20,600,000.

The main winding consists of 72 bars solid copper, 1·33 × 0·2 inch, connected at ends by "butterfly" connectors. Each bar is placed in a separate slot, and the connectors join the 1st to the 36th bar at each end. Thus the two bars in each convolution are one division less than diametrically opposite. The arrangement is that represented in fig. 5. Referring to fig. 5, the commutator, or reverser, bar,

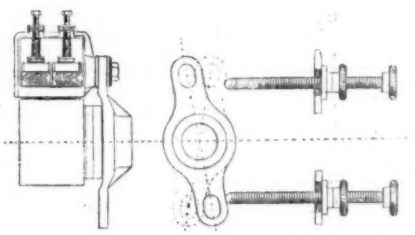


FIG. 13.—AUTOMATIC ROCKER FOR REVERSIBLE MOTOR.

which is just under the pole tip, is joined at the commutator end to the commutator blade. At the distant end it passes over to the slot seventh removed, through which it returns, and is joined to the main bar, which lies in the slot third removed from it.

Magnets.—The magnets are of (so-called) cast-steel, and each half is made in two parts, with a division between them, ½ inch wide, parallel to the magnetic flow, in order to reduce the crowding up of the lines from cross induction, thus carrying out Prof. Thompson's suggestion.

The polar angle is	...	...	...	...	120°.
The air-gap	...	...	...	...	¼ inch.

The shunt winding consists of 325 lbs. of No. 12 wire.

Number of turns	...	...	...	...	2,016.
Resistance at 120° Fah.		...	...	...	10·7 ohms.
Current ...	...	...	...	...	9·35 ampères.
Ampère-turns	...	...	...	...	18,800.*

* This means 9,400 ampère-turns in each limb of magnets.

The weights are as follows:—

	Cwt.	qrs.	lbs.
Magnets, steel castings, &c.	35	3	2
Magnet coils	2	3	17
Armature (shaft, core, and commutator) ...	20	3	15
Windings, main coils, reverser coils	4	3	12
Bearing, rocker, brush-holders, &c.	3	3	1

Fig. 6 is the characteristic of the machine running at constant speed.

Fig. 7 is the characteristic when the engine to which it was coupled was running on its governors.

The engine was built by Messrs. Belliss, of Birmingham, and their test showed an efficiency of $\frac{\text{E H.P.}}{\text{I.H.P.}} = 86$ per cent.

While this test was being made, however, the shunt coils were coupled in parallel, with a resistance in circuit which dissipated 1 per cent. of the total energy. So that the real efficiency of the combined plant is 87 per cent.

ON SLOW CHANGES IN THE MAGNETIC PERMEABILITY OF IRON.*

By WILLIAM M. MORDEY.
Communicated by Prof. SILVANUS P. THOMPSON, F.R.S.

(*Concluded from page* 242.)

Table I. (see also Diagram 1).
Magnetisation = 2,500 **B**. Section of Iron, 49·7 square cm.

Ampères.	Power factor.	Watts.	Date.
0·41	0·74	16·54	August 24th, 1894.
0·50	0·75	20·76	September 20th, „
0·53	0·87	25·65	„ 27th, „
0·54	0·88	26·6	October 5th, „
0·56	0·83	25·71	„ 12th, „
0·58	0·85	26·9	„ 23rd, „
0·59	0·89	28·77	„ 29th, „
0·60	0·81	26·71	November 5th, „
0·60	0·84	27·4	„ 13th, „
0·59	0·82	26·31	December 6th, „
0·61	0·85	28·88	„ 12th, „
† 0·62	0·85	29·03	„ 27th, „
† 0·61	0·81	27·9	January 7th, 1895.
† 0·62	0·81	27·3	„ 25th, „
† 0·62	0·85	28·96	February 7th, „

Table II. (see also Diagram 2).
Magnetisation = 2,500 **B**. Section of Iron, 49·7 sq. cm.

Ampères.	Power factor.	Watts.	Date.
0·55	0·7	20·12	August 27th, 1894.
0·66	0·71	25·8	September 20th, „
0·66	0·84	30·75	„ 27th, „
0·67	0·83	30·55	October 5th, „
0·71	0·75	28·79	„ 12th, „
0·70	0·8	30·99	„ 23rd, „
0·71	0·85	33·08	„ 29th, „
0·71	0·8	30·05	November 5th, „
0·714	0·8	31·46	„ 13th, „
0·7	0·79	29·3	December 6th, „
0·74	0·745	32·54	„ 12th, „
† 0·72	0·87	34·7	„ 27th, „
† 0·73	0·77	30·85	January 7th, 1895.
† 0·74	0·75	30·8	„ 25th, „
† 0·74	0·8	32·87	February 7th, „

Table III. (see also Diagram 3).
Magnetisation = 2,500 **B**. Section of Iron, 49·7 sq. cm.

Ampères.	Power factor.	Watts.	Date.
0·43	0·7	16·61	September 20th, 1894.
0·46	0·8	21·5	„ 27th, „
0·51	0·86	24·28	October 5th, „
0·53	0·8	23·7	„ 12th, „
0·55	0·84	25·61	„ 23rd, „
0·56	0·89	27·67	„ 29th, „
0·56	0·82	25·4	November 5th, „
0·55	0·8	26·16	„ 13th, „
Coil short, circuited		...	December 6th, „

* Paper read before the Royal Society. Received December 19th, 1894.

† Added since diagram was engraved.

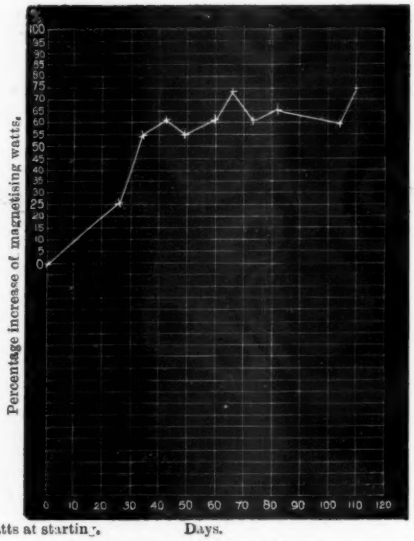


Diagram 1.—(See Table I.).

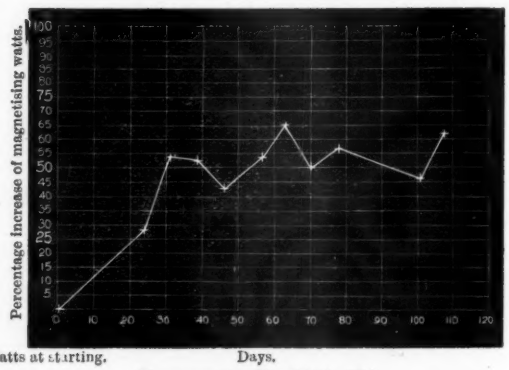


Diagram 2.—(See Table II.).

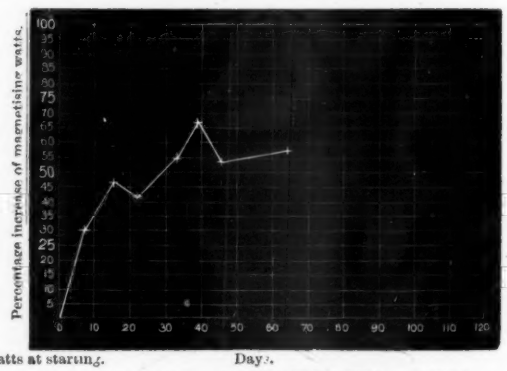
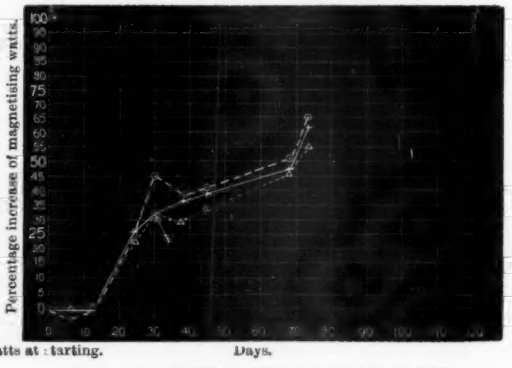


Diagram 3.—(See Table III.).



+ ——— + at B 2,500 (except reading, which was 2,630).
⊙ — — — ⊙ at B 2,762.
△ - - - - - △ at B 3,050.

Diagram 5.—(See Table V.).

This sample was then removed from the oven and left in repose. It was again tested on January 25th, 1895, with the following result:—

Loss at 2,500 **B**, 25·4 watts, showing that repose for 50 days had produced no effect.

Table V. (see also Diagram 5).

Ampères.	Power factor.	Watts.	B	Date.
0·46	0·76	8·9	2,500	
0·48	0·85	10·3	,762	September 29th, 1894.
0·50	0·86	12·1	3,050	
0·46	0·83	8·81	2,500	
0·48	0·8	9·91	2,762	October 5th, „
0·51	0·84	12·08	3,050	
0·49	0·79	8·65	2,500	
0·51	0·78	80·18	2,762	„ 12th, „
0·53	0·81	12·18	3,050	
0·56	0·86	11·15	2,500	
0·59	0·86	12·82	2,762	„ 23rd, „
0·61	0·87	14·79	3,050	
0·58	0·88	11·73	2,530	
0·60	0·9	14·9	2,762	„ 29th, „
0·61	0·92	15·94	3,050	
0·60	0·88	12·13	2,500	
0·61	0·9	14·22	2,762	November 5th, „
0·64	0·87	15·67	3,050	
0·60	0·9	12·35	2,500	
0·62	0·91	14·5	2,762	„ 13th, „
0·65	0·88	16·18	3,050	
0·65	0·87	13·1	2,500	
0·69	0·88	15·5	2,762	December 6th, „
0·71	0·88	17·68	3,050	
0·67	0·9	14·28	2,500	
0·70	0·95	16·96	2,762	„ 12th, „
0·72	0·92	18·76	3,050	
0·64	0·9	13·83	2,500	
0·67	0·9	15·74	2,762	„ 27th, „
0·71	0·9	18·37	3,050	
0·67	0·82	12·7	2,500	
0·69	0·86	15·1	2,762	January 7th, 1895.
0·72	0·84	17·0	3,050	
*0·67	0·83	12·9	2,500	
0·71	0·81	14·64	2,762	„ 25th, „
0·74	0·81	16·82	3,050	
0·69	0·87	13·9	2,500	
0·72	0·87	16·0	2,762	February 7th, „
0·74	0·88	18·4	3,050	

Table VI. (see also Diagram 6).

Magnetisation = 2,500 **B**.

Ampères.	Power factor.	Watts.	Date.
0·37	0·71	7·25	October 5th, 1894.
0·38	0·77	7·99	„ 12th, „
0·46	0·8	10·33	„ 23rd, „
0·46	0·9	11·55	„ 29th, „
0·50	0·84	11·61	November 5th, „
0·59	0·85	11·8	„ 13th, „
0·55	0·82	12·63	December 6th, „
0·56	0·94	14·8	„ 12th, „
0·596	0·86	14·2	„ 27th, „
*0·586	0·80	13·0	January 7th, 1895.
0·61	0·76	12·65	„ 25th, „
0·616	0·82	13·9	February 7th, „

Added February 9th, 1895.

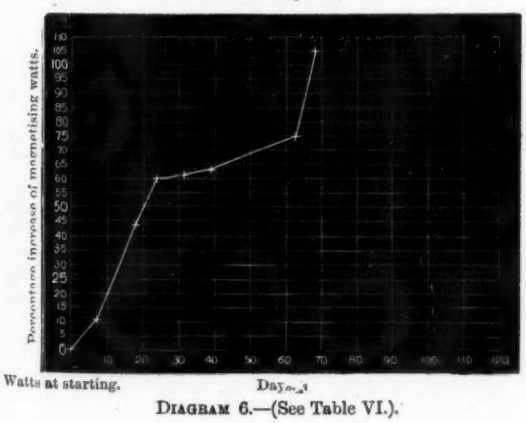


Diagram 6.—(See Table VI.).

Appendix I.

Effect of Pressure without Heat.—The following test on the effect of pressure has been made without the application of heat. A transformer constructed in the manner of fig. 1 was taken and tightened up by hand in the usual way, sufficient for ordinary purposes of construction. The loss on magnetising to 2,180 **B** at 100 ~ was found to be 59·8 watts.

It was then submitted to a pressure of 100 tons, or about 1,500 lbs. per square inch (10·57 kilos. per square cm.), in a direction to force the laminæ closer together, the tightening bolts then being screwed up with the pressure on. On magnetising again to 2,180 **B** the loss was found to be 72·5 watts, or an increase of 21 per cent.

It was kept bolted up in this way for 30 days, and readings taken occasionally, as shown in Table IV., the loss remaining practically unchanged under this continued application of pressure.

The bolts were then slackened, and the loss, on being again measured, was found to be the same as before the pressure was applied.

Thus, without heat, pressure (up to the limits of the test) produces no permanent effect. But that even a very small pressure will increase the permanent effect of heat is shown by the results given in Table VI.

It should, however, be remembered that Table VI. is the record of only a single set of tests, and that it is not known what the effect would have been if the iron had been heated without any application of pressure. It is therefore safe only to say that under considerable pressure, without the application of heat, there is a change of a definite amount, which remains constant under constant pressure, and which disappears immediately on the removal of the pressure.*

It is, however, clear that the slow decrease in permeability under continued moderate heating is not to be accounted for by hardening produced by pressure.

The hardening, which takes place very slowly at these low temperatures, is similar, apparently, to the hardening which takes place when iron is heated to a high temperature, and then suddenly cooled.

Table IV.

(Without application of heat; magnetised only for a few minutes occasionally for purpose of measuring loss.)

	Watts.
Before applying pressure	59·8
During application of pressure of 1,500 lbs. per square inch (10·57 kilos. per sq. cm.)	72·5 on application. 70·2 after 9 days. 72·2 „ 22 „ 70·2 „ 30 „
Without pressure	59·4 on 30th day.

The author has a test in hand to find the effect of heat combined with considerable pressure, but cannot yet give any results.

Appendix II.

The results obtained in this way, so far as the investigation has gone, are as follows:—

A ring was made up of iron ribbon, wound in a close volute, the convolutions separated from each other by paper. This was then wound with a magnetising winding of copper wire covering the whole ring. A test was taken on January 15th, 1895, of the resistance of the iron, and of the energy spent in magnetising it to 2,500 **B** at 100 ~. It was then kept in a oven at a temperature ranging between 60° and 75° C. It was taken out, cooled, and the tests repeated on January 25th and February 8th as below:—

Date.	Temperature.	Watts at 100 ~.	Power factor.	Resistance of the iron.
January 15th ...	17·3° C.	4·9	0·72	$0·94^{10}$
„ 25th ...	17·0° C.	5·4	0·73	0·96
February 8th ...	17·3° C.	6·7	0·8	1·07

Thus the hysteresis loss has gone up considerably, as a result of continued heating, and the resistance has also risen. This result is in accordance with what is known as to the connection between the magnetic permeability and the electrical resistance of iron. Prof. Hughes showed many years ago† that the lower the resistance of iron the better its magnetic qualities.

As bearing on this point, the author has measured the resistance of some soft annealed iron strips, which were then hardened by being heated to redness and quenched in oil at 14° C. It was found that this hardening process increased the resistance 4 per cent. and 7 per cent. in different samples.

Appendix III.

This effect may be illustrated by an example. A transformer was kept in a tank of heated oil, the temperature of which was kept between 110° and 140° C. Readings of its loss were taken occasionally as below, the magnetisation being the same in all cases, the current being applied only at the time and for the purpose of the test.

This test has not yet been in progress long enough to show the slow rise very clearly.

* Added since diagram was engraved.

* Experiments on a solid bar under pressure have been made by Ewing & Low. "On the Influence of a Plane of Transverse Section on the Magnetic Permeability of an Iron Bar," *Phil. Mag.*, September, 1888.

† Royal Society *Proceedings*, December, 1883.

	Watts.	
On immersion	33·13	January 1st, 1895.
After 20 minutes	32·19	
„ 40 „	32·1	
„ 1 hour	32·0	
„ 1 „ 20 minutes	32·0	
„ 2 hours 30 „	31·54	
„ 24 „	28·88	
„ 2 days	29·6	
„ 3 „	30·67	
„ 4 „	31·5	
„ 6 „	36·0	
„ 7 „	33·6	
„ 8 „	36·6	
„ 9 „	32·6	
„ 18 „	32·9	
„ 29 „	35·9	January 29th, 1895.

NEW PATENTS—1895.

2,965. "An improved process for the electro-deposition of aluminium and aluminium alloys." A. F. B. Gomess. Dated February 11th.

2,969. "Portable electric alarm attachable to either lever or pendulum clock or timepiece." W. G. Grossett. Dated February 11th.

2,971. "Improvements in electrically heated curling irons." A. W. Armstrong. Dated February 11th.

2,998. "Improvements in and apparatus for the manufacture of copper, zinc, and other metal sheets, strips, or wires electrically." The Cowper-Coles Galvanising Syndicate, Limited, and S. O. Cowper-Coles. Dated February 11th.

2,999. "Improvements in and means to be employed for the obtainment of zinc from its ores, and the electro-deposition of zinc upon iron or other metals or alloys." The Cowper-Coles Galvanising Syndicate, Limited, and S. O. Cowper-Coles. Dated February 11th.

3,000. "Improvements in secondary batteries." C. A. Faure. Dated February 11th.

3,002. "Improvements in electric arc lamps for photographic purposes." G. Devey. Dated February 11th.

3,003. "Improvements relating to the regulation of electric motors." W. P. Thompson. (Communicated by E. Lauhoffer, A. Burghardt, and J. Burghart, Germany.) Dated February 11th.

3,006. "Improvements in electric arc lamps." W. E. Burnand. Dated February 11th.

3,024. "Improvements in stationary and portable steam pumps, actuated by steam turbines." The Honourable C. A. Parsons. Dated February 12th.

3,055. "Improvements in or connected with electric steering apparatus." F. King. Dated February 12th.

3,062. "Improvements in electric locomotives." E. M. Boynton. Dated February 12th. (*Complete*)

3,066. "Improvements in means for preventing the liquid of primary and secondary batteries being spilt and for rendering it motionless, more especially during transport." E. Henriquez. Dated February 12th.

3,067. "Improvements in electrical storage batteries." E. Henriquez. Dated February 12th.

3,076. "Improved combined telephone and telegraph systems." H. H. Lake. (Communicated by C. A. Shea and F. F. Raymond, United States.) Dated February 12th.

3,081. "An improved ventilating box cover for electric lighting culverts or ways, sewers, cellars, or other places needing ventilation." A. Essinger and W. Parrott. Dated February 12th.

3,085. "Improvements in and relating to electric gas lighting devices." J. Jahnsson. Dated February 12th. (*Complete.*)

3,086. "Improvements in automatic telegraph machines." H. H. Lake. (Communicated by World Flash Company, United States.) Dated February 12th. (*Complete.*)

3,087. "An improved telephone system." H. H. Lake. (Communicated by C. A. Shea and F. F. Raymond, United States.) Dated February 12th.

3,095. "Improvements in and relating to electrical exchange systems." G. W. Hey and A. E. Parsons. Dated February 12th. (*Complete.*)

3,125. "Improvements in brackets for gas, oil, or electric light." C. Meason and T. Ford. Dated February 13th.

3,134. "Improvements in apparatus for indicating or recording telephonic connections." F. W. H. Hempel and A. Maerker. Dated February 13th. (*Complete.*)

3,172. "A method of ventilating the pipes, manholes, chambers, &c., containing the wires conveying electricity through streets and public ways." A. Coke. Dated February 13th.

3,178. "Improvements in and connected with testing and junction boxes, manholes, and culverts for electric light mains and other purposes and in the covers therefor." W. Macpherson. Dated February 13th.

3,179. "Improvements relating to electric light fittings." J. Monteith. Dated February 13th.

3,183. "Process for the production of concentrated sulphuric acid by means of electrolysis." L. Wacker. Dated February 13th. (*Complete.*)

3,226. "An apparatus for steering steamships and other vessels automatically by the aid of electricity and the mariners' compass." F. E. Adams. Dated February 14th.

3,228. "Improvements in the ventilation and combined electrical and chemical purification of the atmosphere in open and closed spaces." J. Frick. Dated February 14th.

3,233. "A combination electric lamp and battery." T. E. Walter. Dated February 14th.

3,250. "Improvements in globes for electric glow lamps." V. de Sprüner-Mertz and J. Koch. Dated February 14th.

3,311. "Improvements in ventilating manhole and lamphole covers for sewers." R. G. H. Worth. Dated February 15th.

3,331. "Improvements in or relating to electric arc lamps." F. W. Dickinson. Dated February 15th.

3,336. "Improvements in or connected with apparatus for electrically lighting miners' safety lamps." W. Ackroyd, W. Best, and J. Peel. Dated February 15th.

3,358. "Improvements in electric railway systems." M. Wheless. [Date applied for under Patents, &c., Act, Sec. 103, December 3rd, 1894, being date of application in United States.] Dated February 15th. (*Complete.*)

3,386. "Improvements in electrical indicators applicable for various purposes." E. Grahame. Dated February 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

62. "Improved method of and apparatus for synchronising alternating current dynamo-electric machines and switching them on and off mains." J. A. Kingdon. Dated January 1st. Claim:—The described method of synchronising alternate current dynamos and connecting them to mains, by mechanically coupling some of the set of dynamos in pairs connecting the idle one of a pair, and an idle one either single or one of another pair to a synchronising bar, exciting the field of the last or of the other one of the pair to which it belongs, and then connecting to the mains.

67. "Improvements in and connected with arc lamps." L. C. H. Mensing. Dated January 1st. Consists in dispensing with the rack and train gear, and substituting therefor a double or divided wheel or pulley pivoted to the lower end of a pendulum which is caused to move through a certain arc by means of solenoids. 4 claims.

646. "Improvements in primary voltaic batteries." W. Walker, F. R. Wilkins, and J. Lones. Dated January 11th. Has for its object to prevent wholly or in great part, polarisation. 2 claims.

1,242. "Improvements in or relating to steam turbines." J. S. Raworth. Dated January 19th. Consists in the combination with the turbine shaft, and the shaft or other rotary body to be driven therefrom, of a novel arrangement of friction gearing. 2 claims.

2,321. "Improvements in or connected with dynamos." W. E. Yates and A. Clegg. Dated February 2nd. A sliding frame carrying the brushes is caused to travel slowly backwards and forwards on the surface of the commutator, thus equalising the wear, and preventing the formation of grooves. 5 claims.

7,116. "Apparatus for calling any desired station on a telegraphic or telephonic line." C. Bradbury. (Communicated from abroad by F. Trinks, of Brunswick.) Dated April 10th. Consists in providing at each station an apparatus composed of three instruments, namely, firstly: A clockwork mechanism serving as a starting apparatus, that is liable to be set in motion by every electric current that is sent through the line wire in signalling, but the motion of which, when only ordinary telegraphing currents of very short duration are passed, is arrested before it can be made to actuate a second clockwork apparatus which puts the call signal into action, this being only possible when a current of a certain duration is sent, and this call signal apparatus contains a controlling device whereby the operator at a central station can determine that the call signal shall only be put in action at the particular station with which he desires to communicate. 9 claims.

9,975. "Improvements in the method of and apparatus for heating, welding, or working metals by electricity." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated May 22nd. In this invention the material being placed in position, electrodes are lowered to make contact therewith and current is turned on, the circuit being through a conductor, the material, one electrode, a brush, a conductor, a contact, a conductor, and the generator. When the circuit is established, the electrodes are raised by a nut and rod, and a voltaic arc is formed between material and one of the electrodes, a conductor is now moved by a band or belt, or by sliding it along a rod, cutting the electrodes in and out of circuit successively and causing the arc to shift its position from the end of one electrode to the end of the next electrode, thus causing the arc to travel a predetermined path, and rendering it easy to heat a seam of considerable length with a very small power. 4 claims.

15,082. "Improvements in magneto-electric machines for cycles or other vehicles, and driving gear for the same." E. Tilmann and C. K. Lexow. Dated August 7th. Consists, in its general features, of a magneto-electric machine, and of a frictional driving gear, which is driven by one of the wheels of the bicycle or other vehicle, and connected by suitable transmitting mechanism with the shaft of the armature of the magneto-electric machine. 8 claims.